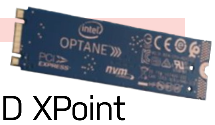
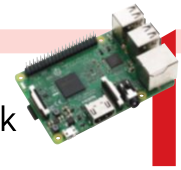


OPTANE 8 SSD
Intel's budget 3D XPoint SSD hits the labs **PG. 80**



RPI ACCESS POINT
Bolster your network on the cheap **PG. 54**

LOCK DOWN FACEBOOK
Take control of your online footprint today **PG. 58**

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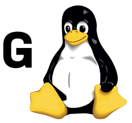
PG.64



START GAMING WITH LINUX
How to play for free **PG. 42**

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see PG. 40

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inside

MAY 2018

QUICKSTART

12 THE NEWS
Real-time ray tracing; AMD rebuffs Ryzen flaws; Facebook loses face.

18 THE LIST
The best gear on show at Mobile World Congress 2018.

The ultra-slim Huawei MateBook X Pro is a serious slice of hardware.

R&D

52 AUTOPSY
Inside the Samsung Galaxy S9+.

54 HOW TO
Build a Raspberry Pi access point; lock down Facebook; record a remote podcast; tilt-shift like a pro.

64 BUILD IT
Step-by-step guides to building our AMD and Intel budget gaming rigs—but which comes out on top?

LETTERS

22 DOCTOR

94 COMMENTS

26 $500 BUILD IT CHALLENGE

26 $500 BUILD IT CHALLENGE
What happens when you take $500 and try to build a 1080p budget gaming machine with either AMD or Intel-based specs? We find out....

34 PERFECT PASSWORD PRIMER
Human laziness, complacency, and unending ingenuity have undermined passwords—it's time to next-gen your security, and save all your passwords!

42 PLAY WINDOWS GAMES IN LINUX
Discover how to get classic Windows games and even old DOS favorites working in Ubuntu, with our comprehensive guide.

IN THE LAB

82 LG 27UD88

79 MSI B350I PRO A/C

87 STEELSERIES RIVAL 600

90 KINGDOM COME: DELIVERANCE

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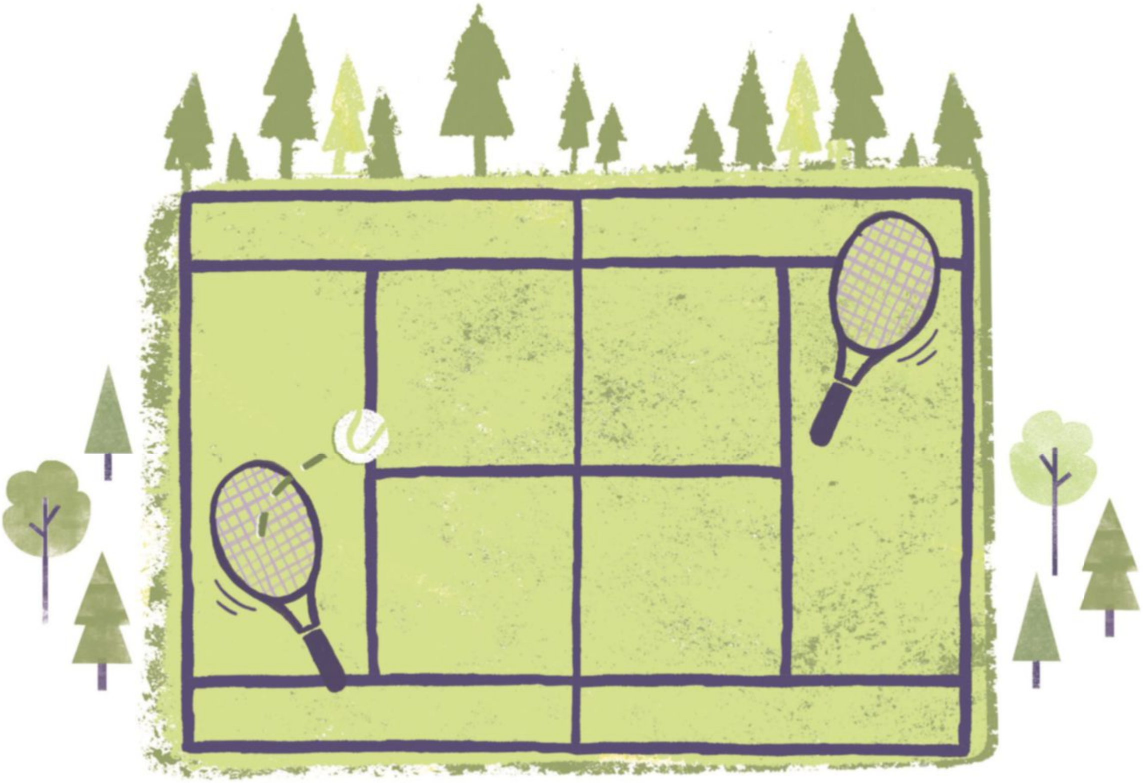

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Tuan
Nguyen

YOU, ME, AND MAXIMUM PC

BACK IN 1996, I picked up a magazine that would forever change my life. It started me on a journey of love—the love for hardware and the PC industry. Many years later, I would write for this magazine, and it would be one of my most memorable experiences. All of that culminated in realizing my dream of being part of the *Maximum PC* staff.

The hardware industry changes regularly, and it changes fast. This is one of the primary reasons why I love it so much. Things keep evolving and moving at such an incredible pace that oftentimes it even becomes difficult to keep up. But that's the excitement that energizes the industry so profoundly.

In the last few years, I've had the privilege of being part of a wonderful team here at *Maximum PC*. We've put out great issues and produced some fantastic work, and I'm very proud of what we've done. But I have to confess: One of the best parts for me was receiving feedback and letters from our readers—yes, people still send in handwritten letters.

I regularly receive letters from readers, some of whom are in prison. There's always a common theme to these letters, and indeed to the emails: They're all very thankful for the work that we do. For some of these readers, a computer and Internet access is not an option. They're limited in their ways of being able to stay in touch with the outside world. But they all have access to hard copies of *Maximum PC*.

Due to the number I receive, I was never fully able to respond to each letter, even though I wanted to. When I first came on board as editor-in-chief, I would try my darndest to respond to every email from readers. It quickly became obvious that responding to every reader would be a full-time job. However, I wanted to take this chance to address all the readers who have written in.

I've read every letter. And at times, some of them have even brought me to tears. Every time I read them, I'm reminded of what I do, and why I love being part of this industry. I'm deeply moved that *Maximum PC* can be the window to the outside world for many of you, and I'm truly happy that I was part of this. Thank you for writing to me—I kept them all.

This will also be the last editor's note that I write for *Maximum PC*, at least for now. I'm off to do something new in the industry that I love very dearly. I leave *Maximum PC* in extremely capable hands, and the team will continue to put out awesome content. I'll continue to be part of the publication, as a subscriber and avid reader.

To all the readers: thank you. You all helped make my dream come true. Tuan out.

Tuan

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 20 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Real-Time Ray Tracing This Year

Photorealistic games are on the way, thanks to DXR

THE AVERAGE API isn't that exciting, but Microsoft's new DirectX Raytracing (DXR) will change everything. We've been looking forward to this for years, and now hardware has reached the point where ray tracing is feasible, and practical to do in real time, in a game. Microsoft has added what the process needs to take root: detailed standardized support embedded into Windows. It's going to look fantastic, too, as long as you have a top-end rig.

The industry has known for months, of course, and has been hard at work behind the scenes. Nvidia announced its RTX Technology for its Volta cards, basically DXR support, as well as tools for the GameWorks library. Futuremark has also been busy experimenting with a ray tracing section for its widely used 3DMark benchmark software—a good sign that the games industry is taking this seriously. The game engines are also on board—Unity, Allegorithmic, EA, Unreal, and Frostbite all plan to add DXR support.

Why all the fuss? Because ray tracing produces incredibly realistic images that are well beyond the capabilities of current game engines. Put very simply, ray tracing is a process that does pretty much what it says. Rays of light are traced from a light source through space, bouncing around the 3D environment, until they reach the viewer. This means you get every reflection, refraction, distortion, color change, and nuance. A simple mirrored ball on a checkerboard was inevitably used to show its capabilities in the early days. It's well beyond that now, as Hollywood has shown; at its best, it can be photorealistic. It is all extremely math-intensive, of course.

The 3DMark people made this, which adds complexity with multiple lights and reflective surfaces, to stretch systems for benchmarking.

Photorealistic ray-traced graphics in a game world have been a long wished-for dream. Here's one of Nvidia's first public efforts.

Meanwhile, at camp AMD, we have Radeon Rays, an API with a different approach. It's open source and conforms to OpenCL 1.2, so can run across multiple platforms. It's currently aimed at professional 3D rendering, rather than games. It's early days yet, and we can expect more from AMD on this; it will have to include DXR support for Radeon cards to remain competitive at the high-end.

Can we really expect fully ray-traced games? Well, this is very complex, and as powerful as modern rigs are, that's a reach. After years of simplifying 3D with clipping and z-buffering, this process needs the whole environment to work effectively. Apart from specialist games, ray tracing will be blended into the mix for now. DXR allows for ray tracing to be used selectively to enhance elements of a rasterized world; shadows and reflections, in particular, which are difficult to do realistically any other way. As hardware improves, the mix will shift toward more ray-traced content, although expect limited light sources and reflective surfaces at first, as these eat math power quickly.

We can't wait to see the results, but releasing an API is a long way from a finished game—witness the time it took for DirectX 12 games to take hold. We'll need new drivers for our graphics cards first. However, things are moving fairly quickly, and there's a good buzz in the air about this. The first fruits are expected before the year's end. Currently, only a fraction of gaming rigs will see the full benefit. But the train is finally on track; real-time ray tracing is coming at you. **–CL**

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AMD REBUFFS RYZEN FLAWS

Zen cores are sound; CTS-Labs takes heat

ON MARCH 12, a little-known research company called CTS-Labs issued a security warning about AMD Ryzen and EPYC chips. It claimed to have found 13 flaws, which could let attackers install malware into protected parts of the processor, exposing passwords and encryption keys. This was hard on the heels of Meltdown and Spectre, and people were understandably twitchy. It received a good deal of coverage, and sounded scary.

Things were odd from the start, though. It is best practice for a security company to give at least 90 days' notice before going public. This gives enough time for patches and fixes to be put in place before alarming the public. Typically, the vulnerability and the patch become public on the same day. CTS-Labs only gave AMD 24 hours before going public.

It took AMD nine days to sift through the report and issue a response. It says all the problems lie with firmware and chipsets, not with the Zen core. It also points out that you need administrative access to employ any of the vulnerabilities; not easy for an attacker to get in the first place, and if they do, you've probably got bigger things to worry about. AMD distilled the flaws into three "issues," and promised BIOS updates and firmware patches to fix any potential problems. Basically, there's little to worry about.

This is an odd one, and the actions of CTS-Labs look reckless. It's a small company, barely a year old. The bugs are real, they've been independently verified, although hardly easy to exploit. CTS-Labs did exaggerate them, including coming up with menacing names such as Master Key and Fallout.

This has ruffled feathers in the industry, and CTS-Labs has been taking heat. There have been accusations of financial gain being a motivation. Linus Torvalds suggested that it looked "more like stock manipulation than a security advisory." Whatever the motivation, the company certainly made a mess of revealing what it had found. **–CL**

FACEBOOK LOSES FACE

SOCIAL MEDIA GIANT'S DATA SECURITY SLAMMED AS LAX

FACEBOOK'S RELAXED attitude to sharing data is coming under increasing pressure from all sides. It is about to lose its chief security officer over a row about how the Cambridge Analytica data breach was handled. Now it looks as though the law is getting increasingly interested. The Senate Commerce Committee and the Judiciary Committee have started sending letters and considering hearings. Meanwhile ex-Facebook employees keep popping up, and describing the company's data security as "lax." One high-level insider in charge of policy violations by third parties claims to have warned it of major data breaches back in 2012. A class action has also been launched by a disgruntled shareholder.

Mr. Zuckerberg has recently put on a suit and tie, and given interviews where he has been apologetic, admitting the company had "made mistakes." He confirmed that the people who put content on Facebook own that content. Exactly, sir, that's why they are so annoyed at it being leaked left, right, and center. **–CL**

CITY BANS CRYPTO MINING

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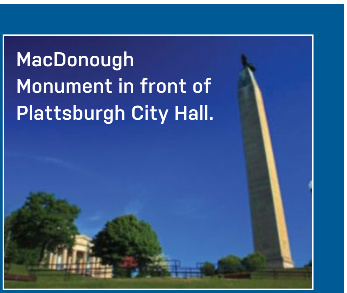

MacDonough Monument in front of Plattsburgh City Hall.

THE CITY OF PLATTSBURGH, NY, sits next to a hydroelectric power station, which means it has—or had—some of the world's cheapest electricity. The national average is 10 cents per kWh, the city charges 4.5 cents, and to promote business, it offered a commercial rate of 2 cents. This soon attracted cryptocurrency miners in some numbers. The trouble is, the power plant only has so much to give: 104MWh a month, to be exact. Anything over this has to drawn from elsewhere at a cost. The rates have proved so attractive to miners that they've exhausted the local supply, and city residents are getting hit by $100 or more extra on their bills.

To slow things down, the city council has imposed an 18-month moratorium on new cryptocurrency mining operations. A major criticism of the first-gen cryptocurrencies, such as Bitcoin, is their huge power consumption; in effect, the cost of power locally determines whether or not it is worth mining them .**–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

WORLD'S SMALLEST PC
IBM has developed a SoC the size of a grain of salt, designed for blockchain and IoT.

APPLE DEVELOPING OWN MICRO-LEDS
Smaller, brighter, and more efficient, the next screen technology may be out this year on the Apple Watch.

HTC VIVE GOES PRO
New lighter $799 headset offers 2880x1600 display, noise canceling, and wireless adapter.

TRAGEDIES

AI CLAIMS FIRST VICTIM?
For reasons that are unclear, an autonomous Uber vehicle has killed a pedestrian in Arizona.

RIP STEPHEN HAWKING
The visionary physicist who popularized something so complicated the population couldn't understand it. Genius.

TITAN V GETS SUM WRONG
Nvidia's Titan V has a hardware glitch that sometimes gives the wrong math answer. OK for games, not scientific uses.

Jarred Walton

TECH TALK

DirectX Ray Tracing: the Quest for the Holy Grail

THE NEXT GENERATION of Microsoft's DirectX API, DirectX Raytracing (DXR), is intended to bridge the gap between rasterization and ray tracing, allowing for new and increasingly realistic renderings. But what exactly is ray tracing, and why do we need it?

The holy grail of computer graphics has been figuring out how to create a perfect rendition of the world around us. Imagine trying model the way the world appears to your eyes. Photons bounce around, emitted from light sources such as the sun, light bulbs, our monitors, or are reflected off other objects. These photons reach the receptors in our eyes, and our brain interprets all of this as an image.

The problem with modeling this is that it all happens on an analog level. Photons are always being emitted, at different rates and wavelengths. A single light bulb emits around 2×10^{20} photons per second—never mind the sun. Simulating every photon bouncing around the world is impractical, and we need something else: ray tracing.

Ray tracing flips the model around and only simulates the photons that would hit a surface—your eye or, in this case, a flat display. Reverse-project a path from each pixel of your display into an environment model, then calculate the final color of each pixel based on reflection, refraction, texture, and absorption properties of the materials. This gives you a decent approximation of the physically modeled view of the environment. The problem is that doing this requires a lot of calculations. The latest Pixar movies are rendered on hundreds of computers, and it still take hours to generate each frame. Games, meanwhile, try to render in real time, at 60fps or more. That's just a bit faster than six hours per frame.

Games do this by approximating graphics in a process known as rasterization. It uses 3D models and textures, with various methods of calculating lighting and colors, to create a 2D representation of a 3D environment. It's generally fast and works well enough, with games becoming increasingly realistic every year. Now rasterization has started using complex techniques such as screen space reflections, global illumination, environment mapping, and more.

If the end goal is to get the best approximation of the way things look in the real world, we circle back to ray tracing. Microsoft's DXR builds on the compute capabilities of the DX12 API, without requiring new hardware, to create a new model for data and graphics. It's a computational workload, which is possible now that our GPUs have replaced most fixed function units with general-purpose gear running shader programs.

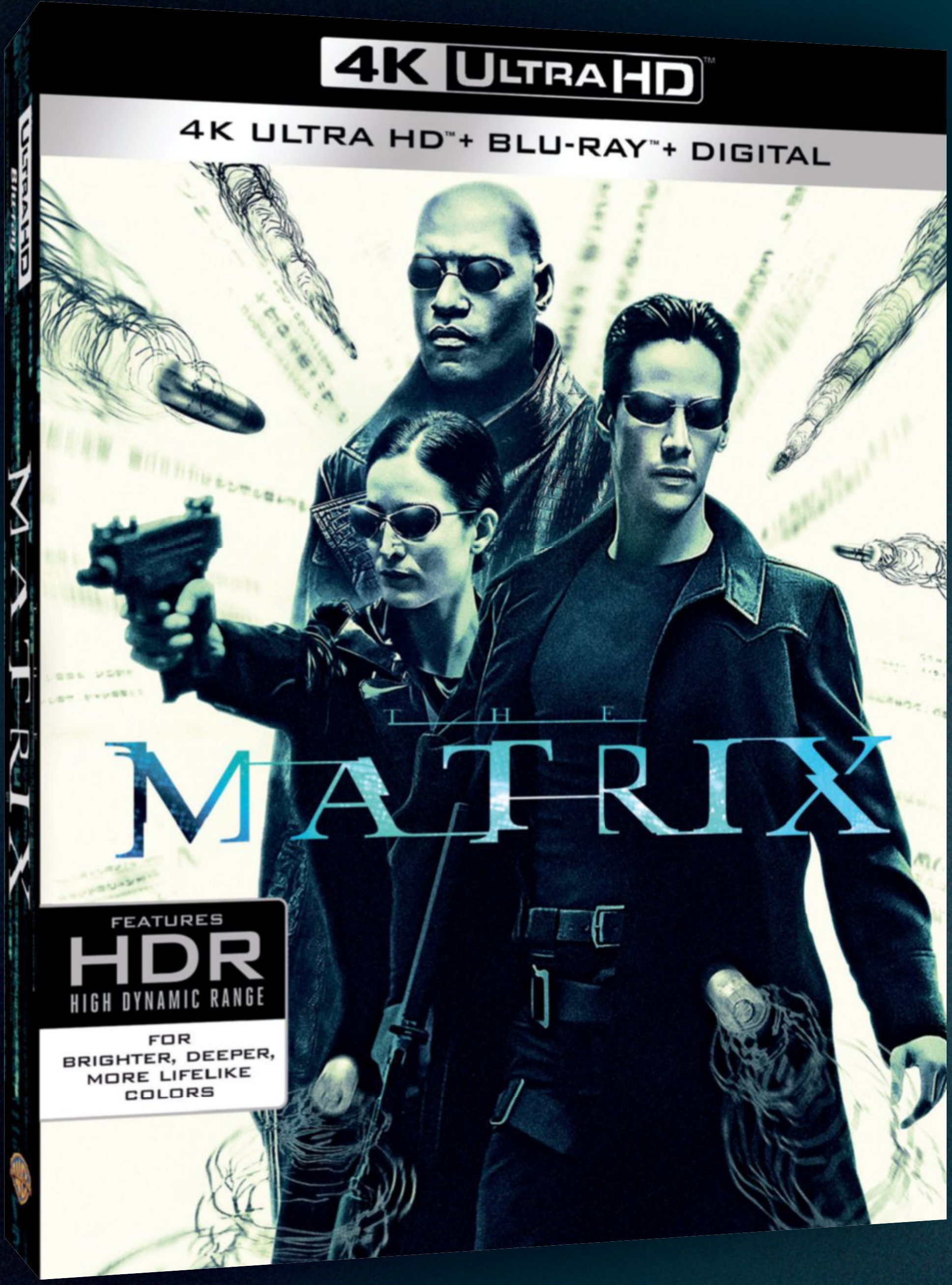
DXR doesn't mean we're going to suddenly start playing fully ray-traced games, however. Ray tracing is more computationally intensive than rasterization, but it allows for new rendering techniques that improve image quality. DXR gives developers a way to shift things like screen space reflections and true global illumination to the new API, with better results and less effort.

Ray tracing isn't a crazy idea that game developers don't want and will never use. If real-time ray tracing becomes possible without a major performance hit, game developers will investigate its uses. Instead of spending resources generating shadowmaps and calculating hacks to simulate the way things should look, ray tracing does the heavy lifting, allowing the artists to focus their energies on creating a great model of their world, and letting the engine do the rendering.

As proof of the interest in DXR, EA, Epic, Unity, and others are already working with it, and early GDC demos show promise. Nvidia has also created Ray Tracing for Gameworks (RTX) built on DXR, promising enhanced performance on Volta graphics chips. That suggests new GeForce cards with enhancements for RTX may be near.

We won't see an immediate transition to ray tracing—GPUs still need to be supported—but we should start seeing forms of it used to improve image fidelity quite soon.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.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Alex Campbell

OPEN SOURCE

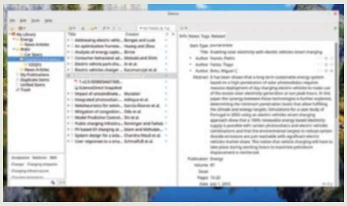
The Research Tool Every Student Needs

FOR STUDENTS AND RESEARCHERS, managing references and articles can be a pain. Proprietary software exists to help reduce that pain, but it costs a pretty penny, and isn't available to Linux users. Luckily, there's an open-source, free alternative.

I first stumbled upon Zotero while perusing through the Document Foundation's list of LibreOffice extensions. While I'd seen it listed on Flathub—a repository for flatpak packages—I hadn't actually looked up what the program does.

Simply put, Zotero is a repository for documents and resources to help people manage their research. Do you remember having to look up how to write an APA or ALA bibliography as a kid? Remember how formatting them in Word was a pain in the backside? I do. Zotero can do all that formatting for you.

Created by the Center for History and New Media at George Mason University under the GNU Affero General Public License, Zotero is a personal research repository. Unlike Evernote and OneNote, the focus is on maintaining bibliographical information for documents and clipped articles. Zotero's main competitor is Calitive Analytics' EndNote, which is only available on Mac and Windows, and costs $250 (discounts are available for students). Zotero offers many of the same core features for Mac, Windows, and Linux, all without the price tag.



The Zotero application on Linux running Gnome.

Zotero essentially comes as three parts: the Zotero program, the browser plugin, and the word processor extension. The main program is where you'll do a lot of the organization of your sources. An entry in Zotero is based on a bibliographical entry; each bibliographical entry can have as many sub-entries as you need. Sub-entries can be images, PDF documents, web snapshots, or user-defined notes. (Notes are handy for pasting relevant excerpts for later use.) Zotero indexes all entries and PDF documents, allowing for full-text searching. Entries can be tagged and put in one or more collections (folders).

> The extension maintains a list of your citations, so it can insert an entire bibliography with a single press of a button.

There are many ways to add entries into Zotero. The Zotero browser extension is available for both Firefox and Chrome, and allows you to add entries to your library without going back to Zotero. The icon for the browser extension changes depending on the context of the web page you're looking at. If you're looking at a book on Amazon, the icon changes to a book. If you're looking at an article in the *New York Times*, the icon changes to a newspaper. (This doesn't work for all news sites, however. I noticed that Zotero didn't identify an *LA Times* article as a newspaper.)

The real power of the web clipper is in what information it saves. The extension saves bibliographical information it can find, but also saves an HTML snapshot of the website as you saw it. If you're looking up journal articles at sites such as Google Scholar, ScienceDirect, or IEEE, Zotero attempts to download the full-text PDF as well. Both the web snapshot and PDF are saved under the appropriate entry in Zotero. The browser extension files the entry into whatever collection you have selected in the main application.

The third part of the application is the word processor extension available for LibreOffice Writer and Word. Out of the box, Zotero allows you to add citations in IEEE, Chicago Manual of Style, and American Psychological Association (APA) formats, to name just a few. To add a citation, you simply click a button and enter search terms in a dialog. Depending on the citation format, Zotero inserts an inline citation, footnote, or endnote. The extension maintains a list of your citations in the document, so it can insert an entire bibliography with a single press of a button.

If you're staring down the barrel of a term paper due at the end of this semester, take a look at Zotero. It might just save you some time, money, and headache.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

THE BEST GEAR FROM MOBILE WORLD CONGRESS 2018

8

TEMI PERSONAL ROBOT

An honest-to-goodness, slightly scary, waist-high robot buddy to follow you around and make you feel like Paulie from *Rocky IV*.

7

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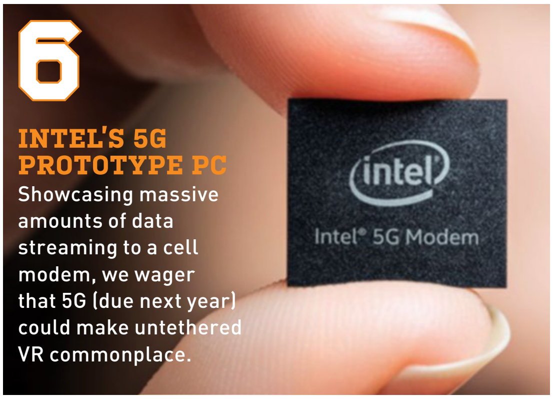
Now you can nail down your network security and monitor traffic levels with a shout to Amazon's ever-present voice assistant.



6

INTEL'S 5G PROTOTYPE PC

Showcasing massive amounts of data streaming to a cell modem, we wager that 5G (due next year) could make untethered VR commonplace.

5

LENOVO YOGA 730

An upgrade to the 720 set to tussle with the Surface Book 2, under $900 for the base model with Alexa.

4

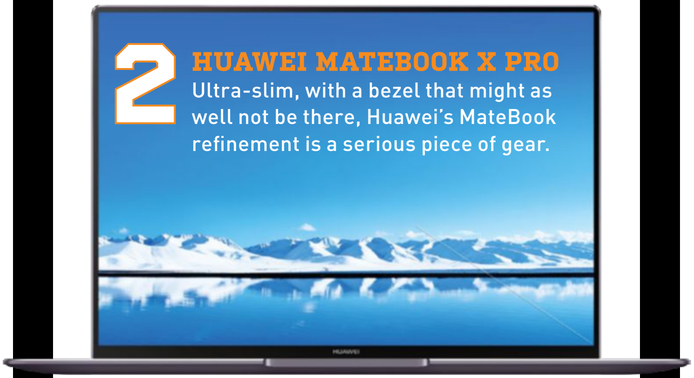
VIVO APEX CONCEPT PHONE

A preview of the all-screen cell phone. This hides its fingerprint sensor in the screen, and has a pop-up selfie camera, too.

3

LENOVO SMART DISPLAY

Move over, Echo Show. Lenovo's latest demo of its Google-infused screen assistant, in 8- or 10-inch flavors, wowed the crowds.



2

HUAWEI MATEBOOK X PRO

Ultra-slim, with a bezel that might as well not be there, Huawei's MateBook refinement is a serious piece of gear.

1

4G MOON ROVER

Nokia, Vodafone, and Audi announce a partnership to stream live video from the moon's surface. Cool, crazy, but why not 5G?

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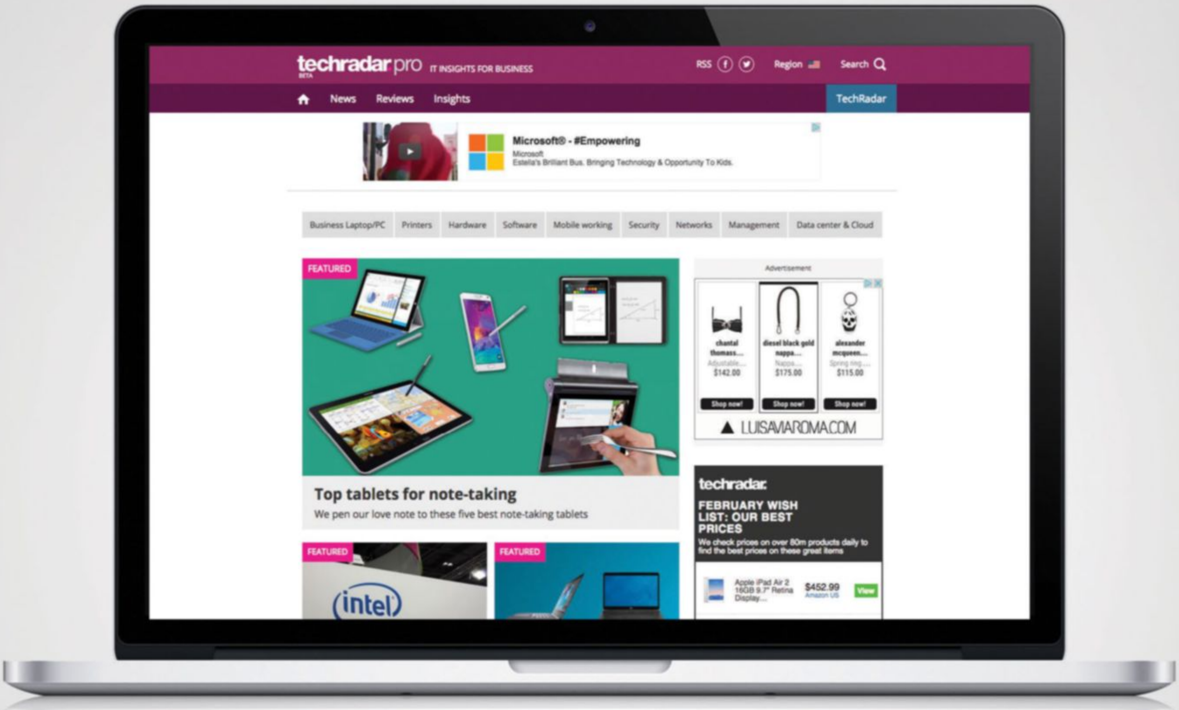
IT INSIGHTS FOR BUSINESS



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TALKING

BY **ZAK STOREY**

Battlezone Combat Commander HD Laid Bare

Big Boat Interactive's Mike Arkin gives us the low-down on what it took to remaster this classic

We sat down with Mike Arkin, CEO of Big Boat Interactive and lead developer of the original *Battlezone II*, to discuss the challenges involved in bringing the FPS/RTS classic into the modern era with the addition of HD graphics and modern-day OS compatibility.

CEO of Big Boat Interactive, Mike Arkin tells us how it is.

Maximum PC: Hi Mike, the question has to be asked: Why now? Where did the desire to remaster this classic come from? Even in its heyday, the original *BZ2* was a somewhat niche title, holding a hardcore base of players and fans, but it never came close to the heights of other RTS and FPS titles of the time. Can you tell us what inspired you and your team to take on this challenge?

Mike Arkin: Well, if we go way back in time, *Battlezone* was a game I worked on back in 1997. For me, it was the first game I worked on as a developer, not a publisher, and it's where I really learned all about game development. But it was more than that. *Battlezone* was something spectacular. In some ways, it was the ultimate RTS, and in others, it was a new experimental genre. We always assumed there would be many more 3D RTS games to follow, and I have to say, all these years later, I'm still shocked it never happened. But the lack of follow-ups and clones means the original games have that much more meaning.

When I was offered the chance to remake *Battlezone 98*, it was the greatest thing I could ever imagine. In some ways, it was like this awesome do-over. Work on *Battlezone* again, and make it better! When we finished *Battlezone 98*, I was hungry for more. It was just like finishing any other game; once it's done, you think of all the things you didn't do, and hope you can make a sequel. In this case, I just finished this great do-over, then there was a chance to do another. Having just finished one redux, we had so many ideas about what we could do better next time. So when Rebellion suggested a redux of *Battlezone II*, it was like Christmas! I guess the question was: How could we not do it?

MPC: What do you think it is about the original *Battlezone II* that captured the imagination of so many players and fans? What makes the game so unique?

MA: Gameplay, 100 percent. That's the reason 15 years later there was still a die-hard group of players playing and modding like it was a new game. It's timeless, and the great thing about the remaster is that the great gameplay is preserved, but it doesn't feel like you're playing something older.

MPC: You worked on the development of the original *Battlezone* and spearheaded the remaster, what similarities were there (if any) when it came to developing these games?

MA: Well, to be honest, it was a pretty different development process. When we were making *Battlezone* the first time, back in 1998, we were really inventing something new, and every new feature was a big surprise. With the remasters, we were keeping the game the same, but it was just polish, polish, polish. The other big difference was that everything was so simple then: 300-polygon tanks, 256x256 textures. Single textures for everything—so simple.

Today, as we're not inventing a new game, it's all about improving the visuals, and how we can make the game better, without breaking the gameplay and turning off the old players. To that end, we're really focused on art and fixing bugs. It's amazing how many bugs you can fix 15 years later! Hint: thousands!

MPC: After playing the HD remaster for a few days now, it feels very much like the old one. From flying, to the way the AI behaves, to the sounds of the weapons, it feels the same, yet new, without even slightly damaging its legacy. How challenging was it to bring the title into the modern age? Is it rewritten from the ground up?

MA: No, not at all, that's the beauty of it. Like with *Battlezone 98*, we started with the basic assumption that we were using the old code as much as we could. *Battlezone 98* was old and crusty code-wise, but in the case of *Combat Commander*, we had a much newer, cleaner codebase to work with, and this made it much easier to add new features to the old code while not breaking the game! So, yeah, if it feels the same, it is the same, but prettier, and with way fewer bugs. For me, the biggest thing that is new is the renderer. We pulled out the old DX6 renderer and wrote a new DX11 renderer with modern shader support, and that's where the awesome visuals come from.

MPC: In a lot of ways, the original *BZ2's* bugs made it the game it was at the time. The community's benchmark for a good scout pilot, for instance, was the ability to hover upside down in mid-air, and fire down at your pursuers. This was fixed in the 1.3 community patch, and has also been fixed in the HD remaster's single-player. Yet you've included the ability to adjust gravity to sort of allow that old-school flying technique in multiplayer. Why did you make that decision?

MA: Hovering scouts was a very interesting case. Some players loved it, and some saw it as a cheat, and hated it. It broke the community in two: the players who loved flying, and those who hated it. Some still want it back, but I'm not sure if that's a good idea. We started with the 1.3 code, so the flying exploit is gone from the game as a result. You can turn on low gravity in a deathmatch game, but the flying exploit is still fixed.

If you can't beat 'em, build more walkers.

MPC: Can you tell us a little bit about your team?

MA: We're a small team: 3.5 engineers—yes, 3.5—and three artists, most of whom worked on *Battlezone 98*. The best part is the two team members who came from the *Battlezone* community. One of the engineers, General Black Dragon, is a long-time *Battlezone* community member and modder, who came to us offering to help with the special effects. In *Battlezone 98,* he did all the redone effects and fixes to vehicle/weapons stats. When we started *Battlezone: Combat Commander,* we needed someone who knew the missions inside and out, and he already had and knew the mission code. He was the perfect addition to the team, and for *Battlezone: Combat Commander,* he was in charge of fixing mission bugs and map issues. It's great to have at least one person on the team who knows the game inside and out, and could help with old issues no one else understood.

On the art side, we needed one more modeler, and we happened to have a volunteer who was a long-time *Battlezone* mod artist. Jaydenbz, as the community knows him, was a really good artist and, again, knew the game inside and out. So we hired him, and he retextured all the Scion units, and did lots of general clean-up. One day, he said he had a great idea for how to make the terrain better, and he blew us away with his terrain test. It was so good, we knew we'd better have him redo it all, and you can see the result in the game today.

MPC: How involved was the community in the development of the remake? How did you take their feedback on board?

MA: The community was very involved. Just like what we did with *Battlezone 98,* I hand-picked 15–20 players, and put them in a private beta test, with the criteria that they were modders and map makers. We wanted to ensure that people could test the tools thoroughly, and guarantee mod content being available day one at launch. That's why we have 38 items on Steam Workshop as of today, and I expect we'll have many more soon.

Say goodbye to 300-polygon tanks.

MPC: Are we likely to see any major patches? A Forgotten Enemies patch, for instance? Or will this all be in the hands of the community from now on?

MA: Yes, for sure, we're still working hard clearing bugs and making changes based on what players are reporting. As for Forgotten Enemies, the original modder isn't around, but I expect one of the other guys will fix it up and release. With the tools we've provided, I expect to see some fantastic mods for *Battlezone: Combat Commander.*

MPC: For us, the biggest change we've enjoyed (aside from the textures, of course) is that models now have an accurate wire mesh for damage—you can shoot through holes in extractors and not damage them, for instance, unlike the original game. Are there any features that you added to the HD remaster that stand out for you?

MA: Well, for me it's all about the modding. While we absolutely needed that mesh collision you mentioned, collision isn't very sexy. Modding, on the other hand, is huge, and can really extend the life of a game. For that reason, we added in game mod selection, so no more command-line nonsense. Also, and this is really great, if you go into a multiplayer game and you don't have the mods the host is running, the game downloads them automatically.

MPC: Are we likely to see the return of the rave cannon?

MA: The rave cannon is in there somewhere. The real question is: Where do we put the super rave cannon?

MPC: Thank you for taking the time to answer these questions, it's been a pleasure. Is there anything else you'd like to add?

MA: I'm just super-excited to deliver a game that is so near and dear to so many people. I hope you love playing it as much as we loved to make it! ⏻

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Hardware Hints
> Audio Acceleration
> On-Die vs. Discrete

Time to Upgrade?

Hi Doc, I've always upgraded at least one component in my PC every year or so, and I find myself in a strange position for the first time in a while: I do not see a stand-out piece of hardware I could swap in that would make a huge performance difference. Right now, the machine includes an Intel Core i7-4790 overclocked to 4.8GHz, a GeForce GTX 1080, a Samsung 850 EVO 500GB SSD, a 2TB mechanical hard drive, an LG 4K monitor, 16GB of DDR3 RAM, an 850W EVGA SuperNOVA power supply, and an NZXT Kraken X61 closed-loop liquid cooler.

My rig is mostly used for gaming, office work, and web browsing. I was thinking about adding more cores, like what I'd get from a Ryzen 7 1800X. But I believe the lower overclock frequencies would affect my gaming performance. What do you suggest I upgrade? Or should I continue waiting for next-gen CPUs and graphics cards to come out? **– Martine & Guy**

THE DOCTOR RESPONDS: It sounds like you're already on the same wavelength as the Doc. With graphics card pricing where it is, high-end GPUs are difficult to recommend right now. A platform upgrade may help tide you over until AMD and Nvidia figure out how to supply gamers and cryptocurrency miners alike.

Coming from a Z87 mobo, stepping up to Z370 gets you a lot more USB 3.0 connectivity, support for PCIe-attached M.2 SSDs, three times as many chipset-based PCIe lanes (not to mention a step up to third-gen transfer rates), and a faster DMI 3.0 link to the CPU.

Of course, this also requires a new CPU and memory. The good news is that Intel's Coffee Lake-based Core i7-8700K is a respectable step up from your overclocked 4790K. More cores, more threads, more cache, and more overclocking headroom all promise better performance in lightly and heavily threaded tasks. The Ryzen 7 1800X you mentioned is another option. It sports more cores and cache, but operates at lower peak clock rates.

But regardless of whether you pick the Ryzen or Core i7, unfortunately a GeForce GTX 1080 bottlenecks many games running at 3840x2160 using high-quality detail settings. If you're most concerned about gaming performance, it's going to take a GeForce GTX 1080 Ti, Titan Xp, or next-gen flagship to raise the bar at 4K.

DAW Speed-Up

Dear Doc, I've been an avid reader for years and love the magazine. I wanted to bring up something I have not seen yet in your section: music editing. I write and record music. Currently, I'm using a DAW (digital audio workstation) called Studio One, along with another program, called Melodyne 4, embedded in Studio One.

My questions involve speeding up something called mastering, which is where the software compresses and mixes multiple tracks into a stereo version. It seems to take forever to do this on my current rig. The songs I am writing have many tracks (the current one is up to 88 tracks, and is 4.4GB in size).

This isn't a slouch of a system, either. I'm running an ASRock Z270 Extreme4 motherboard, an Intel Core i5-7600K, 16GB of G.Skill DDR4-3200 memory, and a 250GB Samsung SSD with Windows 10. If I use the software-based overclocking presets in ASRock's utility to hit 4.6GHz, I can master the 4.4GB file in about 3:25. When I use the Intel Extreme Tuning Utility to hit a stable 5.1GHz through a 51x multiplier, it cuts the time down to 3:04. I measure 1.328V with temps in the high 40s during the mastering process. I've also tried manually overclocking to 5.1GHz by increasing the bus speed to 109MHz, but it makes very little difference.

How might I manually overclock the system so I can decrease this time even more? Or, should I just build a new rig and go the Ryzen 7 1800X route? I didn't know if AMD's latest would improve my performance, but if it helps with your recommendation, this PC is only used to make music. The time involved in mastering a track once is not huge. But when you listen to the mastered file, make a tweak, and master the file again, those minutes add up fast. Cutting seconds off each iteration would help speed up my workflow tremendously.

Thank you, and I look forward to your section, whatever the topic may be.

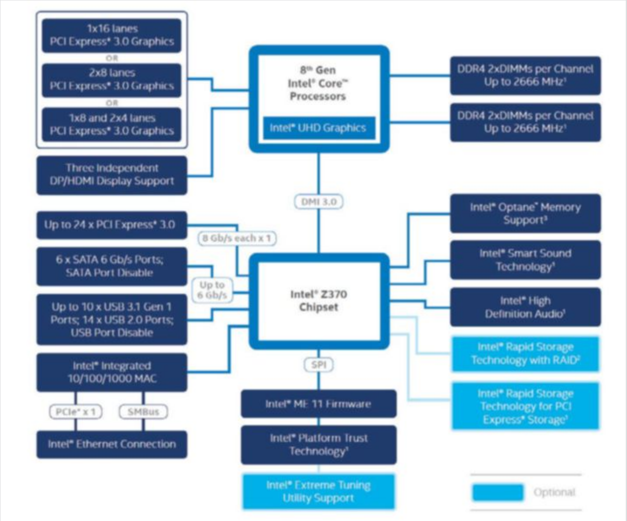
–Rick Breckwoldt

THE DOCTOR RESPONDS: In order to improve performance in a meaningful way, you need to identify your bottleneck. Is this process limited by storage performance? Memory capacity? Processing power? Open up Windows' Resource Monitor while you're mastering

↘ submit your questions to: doctor@maximumpc.com and determine what's getting hit the hardest. Pay particular attention to whether Studio One is completely utilizing one of your i5's cores or all of them.

It's improbable that you'll get much more than 5.1GHz out of a 7600K, and stability problems aren't something you want interrupting your work. If your exploration of performance suggests that the DAW loads all four cores, then yes, stepping up to an eight-core/16-thread CPU should make a difference. But if it's doing that work on a single thread, the Ryzen chip probably won't help much.

Unfortunately, the folks over at PreSonus had no idea what the Doc was talking about when he approached them about accelerating your workflow, Rick. Looks like you'll have to do a bit of digging in order break that three-minute barrier.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Intel's Z370 chipset gives you a lot more connectivity for add-in devices (plus the bandwidth to keep them fed).

Revisiting Graphics

Hello Doctor! I have to disagree with your answer to Lynn Wyatt's question in the March edition of your column. He asked whether he should switch from his Core i7-7700's on-die graphics engine to a discrete card in order to make his display "look better." You told him it wouldn't make any difference if he switched, but I think you missed a few things about his setup and the apps he might be running.

The Asus PA329Q Mr. Wyatt uses is a pro-level, wide color gamut monitor of the kind you want for serious photography, graphic arts, and video. It's capable of displaying 10-bit "deep color" (one billion colors instead of the 16.4 million you get from eight bits). That's a different animal from the "HDR10" color that the Intel HD Graphics 630 in the 7700 supports. HDR10 is a standard that was created for UHD Blu-ray, and if you check the information Intel has about its graphics processors, it says that HDR for content creation applications is "not verified," which could be interpreted as not supported.

For the kind of 10-bit color that some content creation applications support, you need a pro-level graphics card, such as Nvidia's Quadro or AMD's Radeon Pro/Fire Pro. You also need a monitor that supports DisplayPort 1.2 or higher, which the Asus PA329Q does. And you need to be running an application that supports 10-bit color, such as Adobe Photoshop (Lightroom, disappointingly, does not). Granted, the difference between 8-bit and 10-bit color can be very subtle, and to see that difference your source material needs to be in greater than 8-bit color and in a wide-gamut color space, such as Adobe RGB. But if you're serious about photography and you've spent the extra money for a high-end monitor that supports it, 10-bit display color is a good capability to have.

Another point regarding whether a discrete graphics card would be better is that many imaging, video, and other content creation apps use, in varying degrees, OpenGL, OpenCL, and in some cases CUDA to speed up image display and/or image processing (Photoshop filters, for instance). So, the additional graphics processing power that a discrete card adds would go to good use. This may be an even more compelling reason for picking a discrete graphics card over a CPU's built-in engine.

I suggest that he considers purchasing a high mid-level add-in card such as Nvidia's Quadro P2000 or AMD Radeon Pro WX5100, or a low high-end card such as the Quadro P4000 or Radeon Pro WX7100. Any of those choices would give him 10-bit display capability and speed up his applications.

I'm a photographer, and web and graphic designer, not a gamer. I realize that the high-performance computing market, at least at consumer level, is driven by gaming. And I read *Maximum PC,* despite it being mostly about PCs for gaming, because it's one of the best sources for building your own high-performance PC and keeping it tweaked. But I often have to read between the lines to get the kind of information that applies to computers used for content creation.

–Arthur Stoppe

THE DOCTOR RESPONDS: The Doc thanks you for your input, Arthur. Indeed, he focused his response to Mr. Wyatt's questions on display connectivity, resolution, and refresh rate, missing the 10-bit color support of his PA329Q.

Dueling AV Suites

Doc, I'm bugging you because my brown belt Google-fu is failing me. I'm running Malwarebytes Premium 3.3.1 on my system, in conjunction with Norton 360. The two play fine together, and I've had no issues running them together (*Maximum PC* actually recommended running both a couple of years back).

The issue I'm having is that I keep getting pop-ups from Malwarebytes saying it blocked a malicious outbound request by www.favgame.net. I have run numerous full scans with Norton and Malwarebytes, including rootkit scans, and neither finds a threat on my system. I've searched through installed programs, and even run full registry searches for "favgame," and can't find anything on my drive related to it. I don't have any games installed that use Favgame.net, either.

I've dug through pages of Google/Bing search results about the issue, as well as through the Malwarebytes forums, and I can't find any information on the cause of these warnings. My router's firmware is updated, all Windows security patches are installed, and I keep Norton/Malwarebytes current with regular scans. Nothing nefarious is ever detected on my system. The detection event always indicates the offending file is located in C:\Program Files (x86)\Norton Security with Backup\Engine\22.11.2.7\ncolow.exe, so I'm wondering if this is some type of conflict between Norton and Malwarebytes.

–B.J. Koho

THE DOCTOR RESPONDS: The process ncolow.exe belongs to Norton's Identity Safe password manager. You might want to dig into that to search for any reference to Favgame.net.

Otherwise, you can either disable Malwarebytes' real-time protection or add a Malware Exclusion to Malwarebytes, which prevents it from including the Norton Security with Backup folder in its scans.

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intel CORE i7 8th Gen

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AMD BUILD
Step-by-step guide PG. 64

AMD INGREDIENTS

PART		STREET PRICE
Case	Cooler Master MasterBox Lite 5 RGB	$70
Motherboard	MSI B350 PC Mate	$80
CPU	AMD Ryzen 3 2200G	$100
Memory	8GB (2x 4GB) Corsair Vengeance LPX DDR4-3000	$110
PSU	Corsair CX 450W	$24
Storage 1	Kingston SSDNow UV400 120GB	$51
Storage 2	Western Digital Caviar Blue 1TB	$47
TOTAL		$482

$500 BUILD IT CHALLENGE

What happens when you take $500 into today's market, and try to build a 1080p budget gaming machine with either AMD or Intel-based specs?

INTEL INGREDIENTS

PART		STREET PRICE
Case	BitFenix Nova TG	$50
Motherboard	Gigabyte Z370P D3	$96
CPU	Intel Core i3-8100	$114
Memory	8GB (2x 4GB) Team Vulcan DDR4-2400	$96
PSU	EVGA BT 450W	$28
Storage 1	Kingston SSDNow UV400 120GB	$51
Storage 2	Western Digital Caviar Blue 1TB	$47
TOTAL		**$482**

GIGABYTE
Kingston
WD
1.0TB
WD Blue

INTEL BUILD
Step-by-step guide PG. 68

REMEMBER WHEN BUILDING A PC was an affordable pastime? Remember when graphics cards used to be in stock? Remember when a reasonable upgrade path used to exist? *Maximum PC* remembers....

All joking and old advertising slogans aside, it wasn't so long ago that these things were a given. It was that age-old argument we could turn to when confronting people who had bought laptops or consoles: We saved money, and got better performance for it in the long run. Oh, if only that were still the case. Go back to our January 2017 issue, and our budget build—complete with Core i5-6500, 8GB of DDR4, GTX 1060, 256GB SSD, and 1TB HDD—came in at an impressive $801. Today? You're talking $997 at a minimum for an almost identical spec. That's zero improvement on performance, and a 24 percent price increase, over the course of less than a year and a half. Sad times indeed.

So, what counts as budget today? Well, that's what we're here to find out. With both Intel and AMD pushing the boundaries of next-generation CPUs, whether that's with integrated Vega graphics or more cores than we've ever seen before, is it possible to build a gaming machine that functions without a discrete GPU? We've already seen what the Ryzen 5 2400G can do, but what about its younger sibling? And AMD aside, how about Intel? Can those additional two cores bring Kaby Lake's architecture into contention with AMD once again? Read on to discover how the competitors shape up.

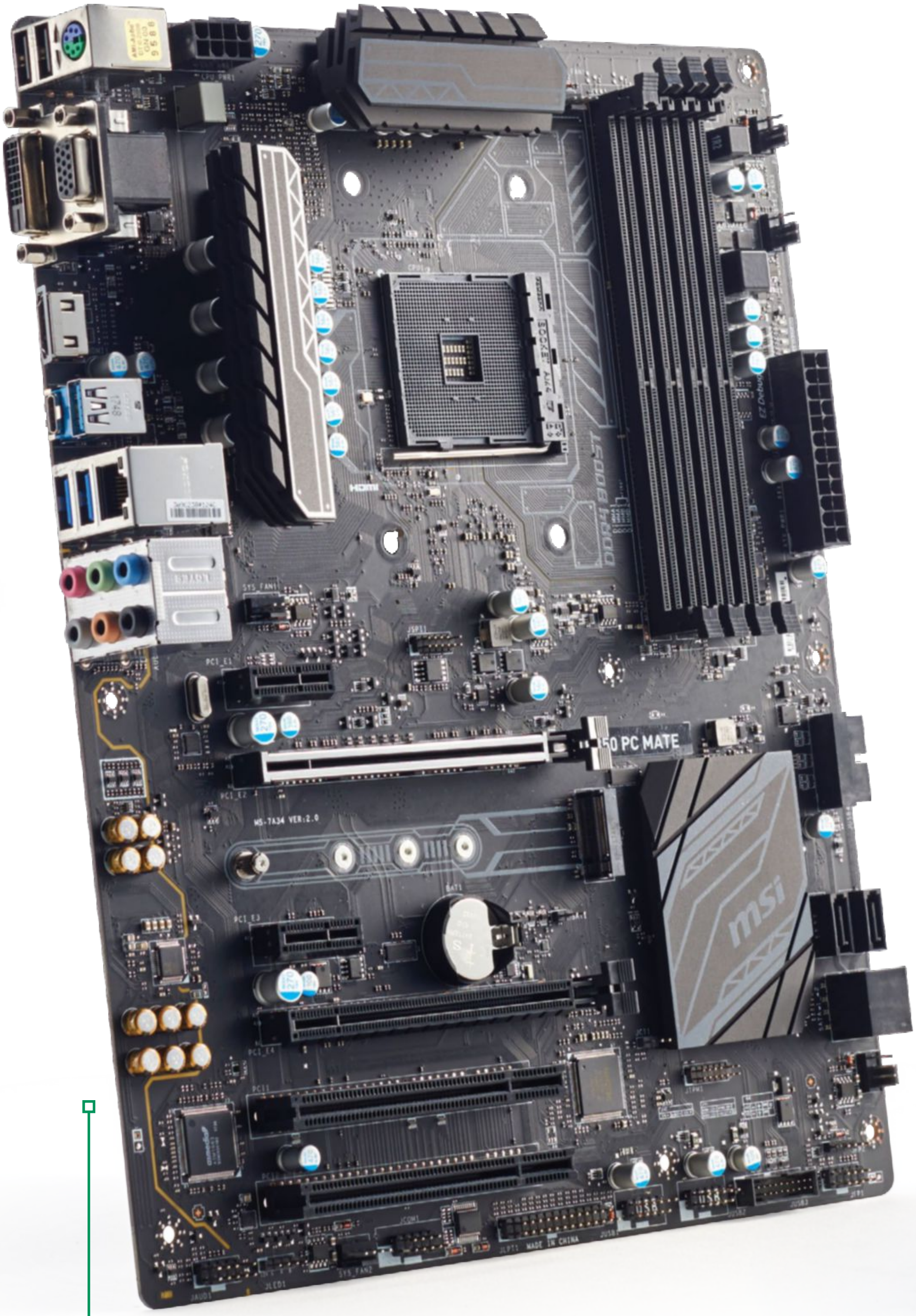
AMD BUILD
Step-by-step guide PG. 64

AMD Ryzen 3 2200G
AMD RYZEN

AMD CPU

AMD Ryzen 3 2200G $100

IT MAY ONLY COME with four cores, but don't count the Ryzen 3 2200G out just yet, because it packs a very comfortable core clock, maxing out at 3.7GHz, and features eight of Vega's advanced compute unit graphics (three fewer than the Ryzen 5 2400G), making it a deceptively powerful part for the price.

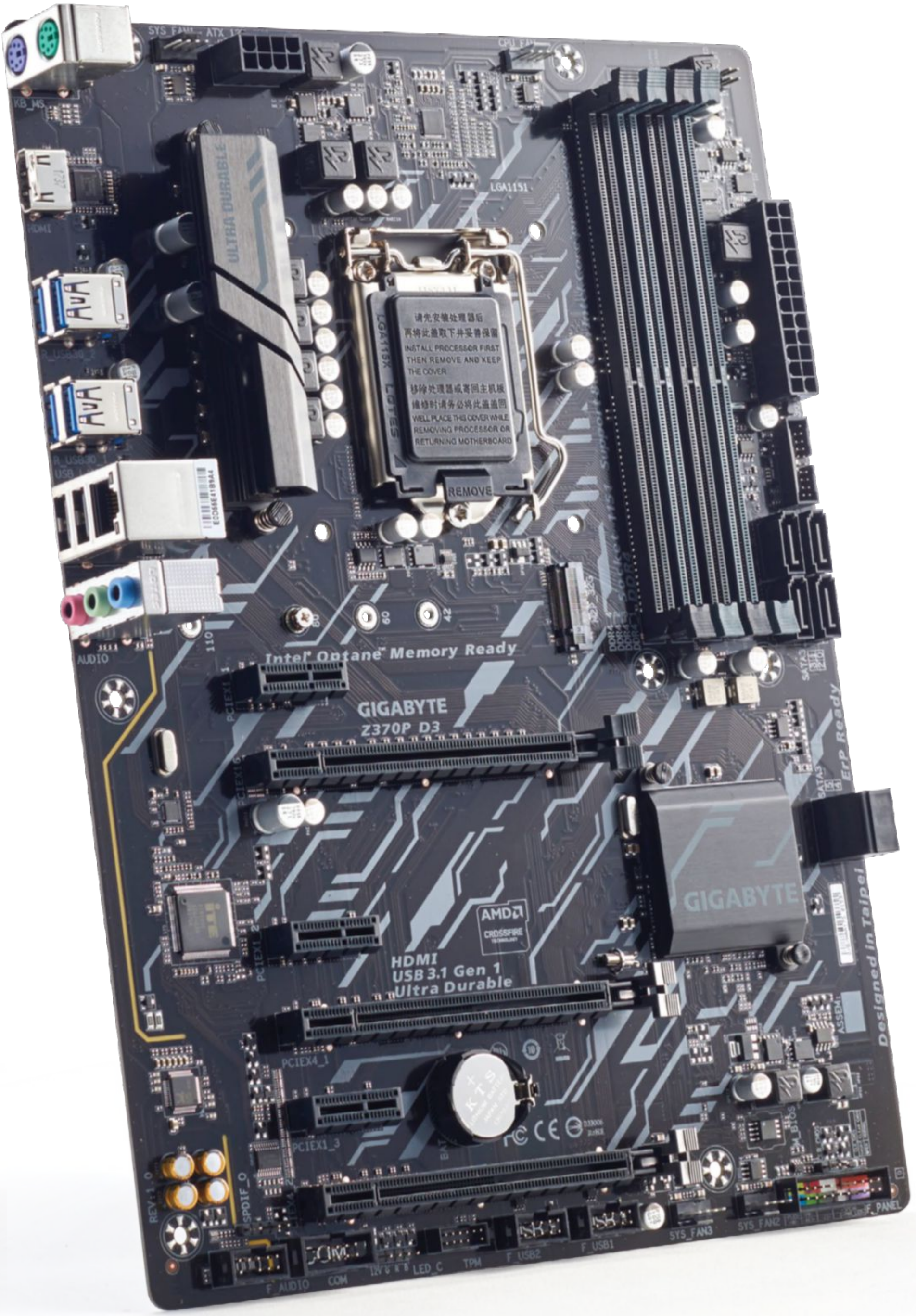


AMD Motherboard

MSI B350 PC Mate $80

WE'VE GONE WITH MSI's B350 PC Mate for our AMD-specced rig, and boy does it pack the features in. With a stylish design and support for plenty of everything—including M.2 PCIe SSDs, SSD USB 3.1, and even USB 3.1 Type C in the rear—it's the perfect partner for those looking to advance up the Ryzen chain later down the line.

INTEL BUILD
Step-by-step guide PG. 68


GIGABYTE
Z370P D3
Intel Optane Memory Ready
HDMI
USB 3.1 Gen 1
Ultra Durable
ULTRA DURABLE
GIGABYTE
Designed in Taipei

Intel Motherboard

Gigabyte Z370P D3 $96

THIS IS THE PROBLEM with any current budget Intel build: There's just not enough budget boards. Seriously, this is one of the cheapest you can get, at least until the more budget chipsets launch later this year. That said, it's jam-packed with expansive connectivity, looks the part, and—combined with the unfettered grunt of the Core i3—there's plenty here for upgrading later on.

INTEL® CORE™ i3
i3-8100
SR3N5 3.60GHZ
L734C924 e4

Intel CPU

Intel Core i3-8100 $114

INTEL'S CORE I3 parts have always been somewhat synonymous with poor performance. It's only recently, with Kaby Lake and Coffee Lake, that we're starting to see things picking up. Basically, this is a Core i5 of yesteryear, packing all the brilliance of Coffee Lake into a very affordable package. With a 3.6GHz base clock and low power draw, it's more than capable of powering any gaming rig today—or tomorrow.

AMD BUILD
Step-by-step guide PG. 64

AMD Case

Cooler Master MasterBox Lite 5 RGB $70

THIS CASE IS absolutely packed, especially given the price. The style, the design, the tempered glass, the lighting, and the included fans—it's all there. With support for ATX motherboards, SSD mounts, PSU cover, and plenty of cable management room, it's a damn fine chassis.

AMD PSU

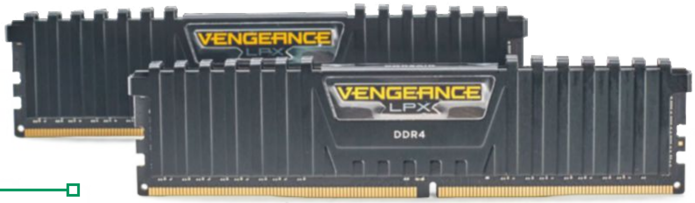
Corsair CX 450W $24

THE ONLY REASON we've gone with such a cheap power supply is because we trust the brand entirely. Corsair has never let us down when it comes to PSUs, and we don't expect it to now. That aside, this is a 450W PSU, and our system should only draw around 200W from the wall at most, giving us plenty of headroom, and allowing for a GPU if we so desire.

AMD Memory

8GB (2x 4GB) **Corsair Vengeance LPX DDR4-3000** $110

8GB OF DDR4 is the minimum we can get away with for integrated gaming. We've gone for a 3,000MT/s kit as that just hits Ryzen's sweet spot for maximum Infinity Fabric performance. If HTPC, web browsing, or a home office is your thing, cut the frequency, drop the capacity to 4GB, and you'll be good to go.



OS Storage

Kingston SSDNow UV400 120GB $51

FOR OS STORAGE, we've picked a Kingston SSDNow UV400. You can get the A400 slightly cheaper, at $44, but we're happy to pay an extra $7 for the additional 50MB/s sequential read and write speeds. It's not super-quick on reads, but it's a hell of a lot faster than any old-school spinning platter.

INTEL BUILD
Step-by-step guide PG. 68

Intel Case

BitFenix Nova TG $50

BITFENIX'S NOVA TG is nothing short of incredible. Packing expansive hardware support, some solid cooling, cable management room, and even a tempered glass side panel, it's an awesome combo of computing chassis creativity, ready for any would-be budget builder. You even have the choice of a black or white version, depending on your preference.

Intel Memory

8GB (2x 4GB) Team Vulcan DDR4-2400 $96

ONE OF THE BENEFITS of using the Intel architecture is its lack of reliance on memory frequency. Sure, you'll see some benefit in more enterprise workloads, but for mainstream consumers? Zilch. That means we can save some cash, and opt for a 2,400MT/s kit instead of the 3,000MT/s one we got for the AMD build.

VULCAN
VULCAN
TFORCE

Intel PSU

EVGA BT 450W $28

WE KNOW FOR A FACT that our little Intel rig is going to draw no more than around 170W from the wall, so again we've gone for a sweet little 450W number, this time from EVGA, to provide the juice. It's a known brand—just in case anything does go wrong, EVGA's warranty team is there to help us out of a jam—and, of course, we can pop in a GPU at a later date, too, if need be.

Additional Storage

Western Digital Caviar Blue 1TB $47

AND, OF COURSE, where would we be without a big old trusty backup drive in the form of a 1TB Western Digital Blue? It's our go-to drive for budget builds, and with good reason: It's a fantastic brand, and has an impressive gigabyte-per-dollar rating. What's not to love?

WD
1.0TB
WD Blue

Built to Budget

Intel and AMD have both upped their game in regard to budget CPUs with integrated graphics—which should you pick?

WE SET OUT with one goal in mind: To game comfortably at 1080p without much fuss. When we first started looking at these two processors, our immediate questions revolved around how capable they were in game. After all, AMD's top-end Raven Ridge APU touted an impressive 11 Vega compute units, and although that pales in comparison to Team Red's flagships, Vega 56 and 64, it's still substantially more clout than we're used to from integrated graphics.

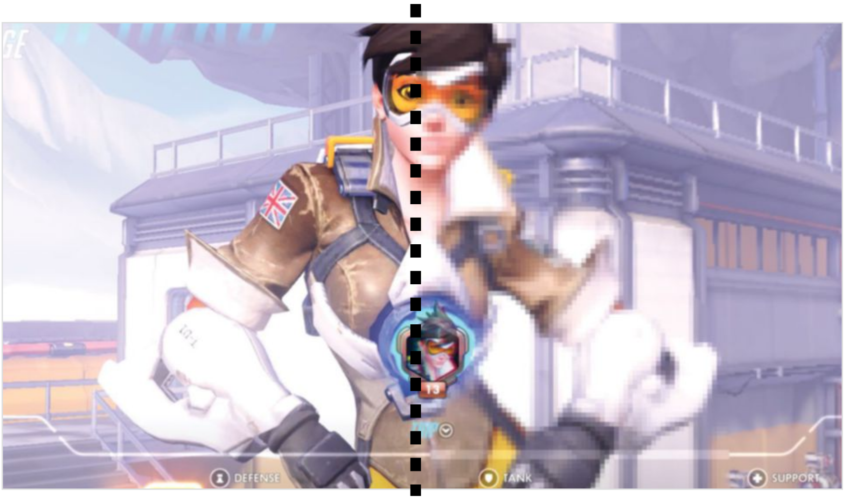
Unsurprisingly, the Ryzen 3 2200G came out on top. Impressively so, and especially in games such as *Overwatch* and *Fortnite*. So that's it? Cut and dry? AMD wins? Not quite. Intel still has a solid grip on those productivity reins. Thanks to its mature architecture, and ironically poorer integrated GPU performance, not only does the Core i3-8100 impressively clean up in almost all of our computational and system benchmarks, but it also has a far smaller footprint when it comes to power draw.

Is that Intel's only saving grace? Kind of—it's a bit of a hollow victory. After all, it's far easier to discern the difference between 20 and 40fps in game than it is noticing whether your Word document opens 0.4 seconds faster on one platform than the other. And that's the crux of all this. Sure, if you must have definitively the best processor out of the two, and it's purely for office or day-to-day work, Intel's likely your best bet. But like comparing a PCIe SSD to an SSD, as opposed to comparing an SSD to an HDD, the difference is far less obvious at this level. Ryzen still performs all of your day-to-day tasks with minimal fuss, yet it has that additional Vega grunt to pull your system into light gaming and encoding tasks. It's worth noting that an optimized gaming engine does make a big difference. Even the Intel machine turned out semi-reasonable frame rates in *Overwatch* if allowed to pick optimal settings. It may not look particularly good, but sometimes you want smoothness over visual fidelity. The fact that we were able to play competitively on the AMD machine in *Overwatch* and *Fortnite* shouldn't be understated, though, and the Ryzen 3 2200G is a genuine option if you want to play popular games on the cheap. You'll need to pop into the BIOS and set aside 2GB for your GPU to hit these frame rates, but that's easy enough.

One test that we suspected would be an easy win for Intel was the number of frames dropped when playing back 4K content. But in practice, AMD produced the smoother playback, although only just. Again, you'd

AMD BUILD	SYSTEM BENCHMARKS	INTEL BUILD
3,003	PCMark10 (Index)	**4,158**
44	4K Video Playback (Dropped Frames)	50
98	Power Draw Load (Watts)	**79**
12.88	X265 Benchmark (fps)	**14.27**
74.6	Aida64 Memory Latency (ns)	**65.5**
149	File Extraction (Seconds)	**122**

Best scores are in bold. All games tested at 1080p. *Overwatch* tested at medium settings; *Tomb Raider, Tom Clancy's Ghost Recon Wildlands, Fortnite,* and *Total War: Warhammer II* tested at low settings.



***Overwatch* automatically reduces the render scale depending on your GPU's capacity.**

be hard pushed to spot the difference between the two, and in fairness, you'd suspect they were both silky smooth. A drop rate of 0.52 percent for Intel versus 0.46 percent for AMD isn't noticeable either way. Try the test yourself at www.youtube.com/watch?v=mkggXE5e2yk. Select "2160p60" from the quality cog, right-click the video, and select "Stats for nerds."

There's one more thing our plucky blue under-runner has to its advantage, and that comes down to its base architecture, and the number of PCIe lanes each chip supports. If you're looking to throw a solid mid-range GPU into one of our builds a month or five down the line, the Intel Core i3-8100 packs a full complement of 16 PCIe lanes set aside for dedicated graphics. Swap over to Ryzen, and you're met with half that. With 16 lanes, the likelihood of hitting any bottlenecks with a single GPU at 1080p is relatively slim, but cut that number in half, and there's the potential that you may well run into performance issues.

On the flip side, Ryzen has the platform advantage. AMD is intending to stick with the AM4 socket for the foreseeable future, at least until we go down to 7nm. This means that in a year or two, you could throw out that old Ryzen 3 2200G and replace it with a Ryzen 5 3600X, or maybe go for a newer APU with more Vega cores. Intel, on the other hand, has a long history of switching platforms and sockets, so that Core i3-8100 build you've put together is essentially end-of-life the moment you turn it on.

Conclusion time: Which system should you build? Well, that depends. If you're not interested in ever playing games, the Intel machine has a bit more raw power for everyday tasks, so that's your best choice. If you like to dabble in a little gaming, but don't want to drop serious cash on a graphics card right now, the AMD build is the way to go. It's surprisingly capable. However, if you're more of a gamer than that, this is where it gets tricky—the reduced number of PCIe lanes on the Ryzen 3 2200G ultimately does make a difference to the performance the system can deliver, while Intel's integrated GPU is essentially pointless. Which means that neither system is quite right for you. In other words, serious gamers are going to need to spend more cash from the start.

Graphics Cards

Dedicated Upgrades

SO, ABOUT THOSE PCIe lanes—this is where things get interesting. We decided to throw our budget GPU of choice, the GTX 1060 6GB (pictured below), into both of these rigs to see how dramatically that cut in PCIe lanes affects our Ryzen APU. After all, Ryzen doesn't typically fair quite so well with a dedicated GPU compared to its Intel counterparts, so surely that reduction won't help.

The results? Perhaps not as pretty as we'd like. Our first batch of tests were performed at 1080p, at the same low settings that we originally tested our APUs. Our Intel build scored 135, 110, and 111 frames per second in *Rise of the Tomb Raider, Total War: Warhammer II,* and *Ghost Recon Wildlands* respectively. Our AMD build scored 113, 82, and 91fps in the same titles. That's an average decrease of around 20 percent. Bump uglies with those Ultra graphical profiles, and it's a similar story, averaging a 17 percent decrease in performance. Check out the Ultra scores below.

GTX 1060 GAMES—ULTRA

AMD BUILD		INTEL BUILD
70	RotTR (Avg fps)	82
39	TW:WHII (Avg fps)	48
33	GR:W (Avg fps)	41

GAMING BENCHMARKS

AMD BUILD		INTEL BUILD
54	Overwatch (Avg fps)	23
61	Fortnite (Avg fps)	26
35	Rise of the Tomb Raider (Avg fps)	12
22	Tom Clancy's Ghost Recon Wildlands (Avg fps)	11
21	Total War: Warhammer II (Avg fps)	10

Best scores are in bold. All games tested at 1080p. *Overwatch* tested at medium settings; *Tomb Raider, Tom Clancy's Ghost Recon Wildlands, Fortnite,* and *Total War: Warhammer II* tested at low settings.

PERFECT PASSWORD PRIMER

Human laziness, complacency, general failings, and unending ingenuity to subvert systems have undermined passwords forever. It's time to next-gen your security, and save all your passwords! *By Neil Mohr*

IN ANY SYSTEM, humans will find a way to subvert the rules for their own gain. It's a recurring theme: from skipping class, cheating in games, fixing the banking system, and exploiting welfare, down to stealing from work, and gambling in Vegas. So it shouldn't be a surprise that most humans choose the lazy option when it comes to password security.

It's too easy just to say humans are lazy, and pin terrible password security on that. Humans will always attempt to game systems at both ends, which is why passwords are being hacked and people want to avoid memorizing them in the first place. It's not good enough to just use a strong password; we now live in a world where so much is tied up with our online lives that hackers are doing more and more to break into online accounts.

So, we're going to look at the whole subject of password security, and hence online account security, how we can choose better passwords, how we can make our lives easier but also safer, how we can increase protection beyond passwords, and how hackers attack and use your account details.

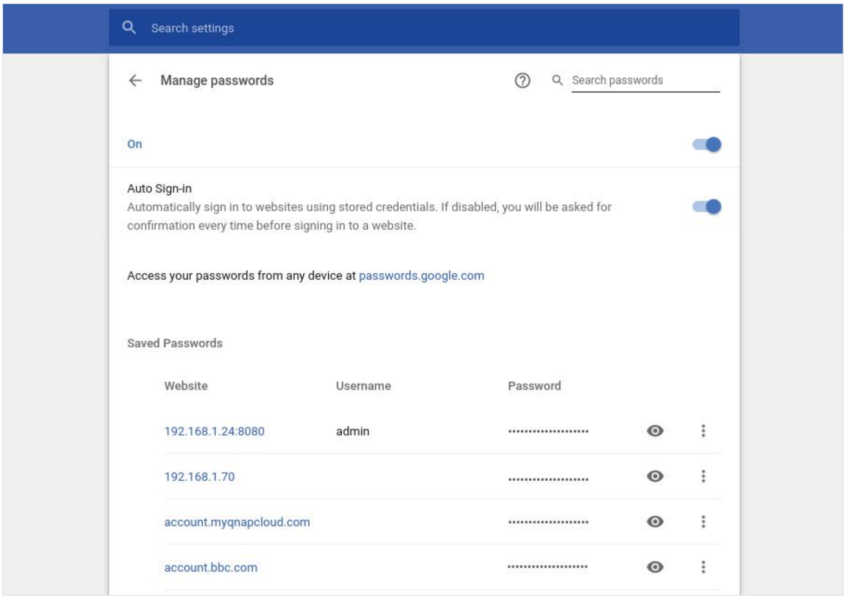
Some of this advice you'll have probably heard before, some of it is hopefully new, but by the end, you'll be suitably terrified that you'll overcome your human propensity for laziness, and get up off your ass, and protect your passwords!

NETWORK
34
[PROCESSING]
▶02
//HACK ATTEMPT FAILED
//SCAN
NETWORK
NNECTED
USER SAFE
//SCAN
▶12.123.8234

LET'S START by scaring the heck out of you. There has been a host of research on password security, made much easier by the huge number of database breaches in recent years. One of the widest-ranging research efforts was by Google, published mid-2017 in its "Data breaches, phishing, or malware? Understanding the risks of stolen credentials" paper (https://research.google.com/pubs/pub46437.html).

Some sweet nuggets from that little cache include the fact that the researchers swept over 1.9 billion non-unique account usernames and password credentials. These were taken from a variety of leak sources, but mostly blackhat security forums. An insane 76 percent of these could be (or already were) easily converted to plain text (best practice is to hash and salt stored credentials). The researchers were able to reverse an impressive 36 percent of hashed passwords, using a suitable keyword attack.

Of those stolen via phishing attacks, 49 percent were from Americans. When it came to pure security leaks, 39 percent of credentials were linked to Americans. As for credentials stolen via keyloggers, Americans were targets in 8 percent of incidents; Brazil accounted for the highest amount in this group at 18 percent.


Search settings

Manage passwords

Search passwords

On

Auto Sign-in
Automatically sign in to websites using stored credentials. If disabled, you will be asked for confirmation every time before signing in to a website.

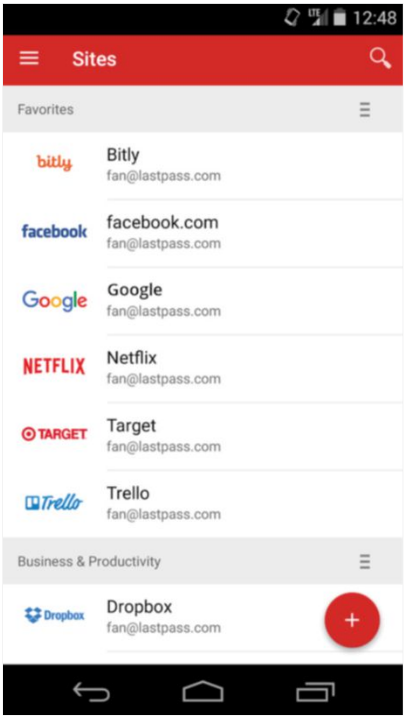
Access your passwords from any device at passwords.google.com

Saved Passwords

Website	Username	Password
192.168.1.24:8080	admin	••••••••••••••••••
192.168.1.70		••••••••••••••••••
account.myqnapcloud.com		••••••••••••••••••
account.bbc.com		••••••••••••••••••

Google Chrome can manage and synchronize passwords across your devices.

Credential leaks appear to happen regularly these days. The largest ever remains the initially hushed-up Yahoo leak, back in 2013, in which pretty much every Yahoo account ever was leaked, totaling 3 billion. Adult Friend Finder topped 412 million, the 2017 Equifax breach hit 143 million Americans, while MySpace, Adobe, LinkedIn, Dropbox, LastFM, NexusMods, and many more have all had their leaks, each individually releasing millions of users' details.


12:48

Sites

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Business & Productivity

Dropbox
fan@lastpass.com

A well-integrated mobile app handles online accounts and local app logins.

These leaks show the basic issue with password reuse: If you are using the same password across all of your online accounts, it just takes a single leak to contain that password, and all your accounts are compromised.

SCIENCE SAVE US!

So the logical next question is: What makes a secure password? Entropy. That means the level of randomness in a system. By randomness, we mean true randomness. It's not enough to have a long password, it has to be long and truly random. We stumbled across a lovely analysis of poor passwords by WPEngine, at https://wpengine.com/unmasked.

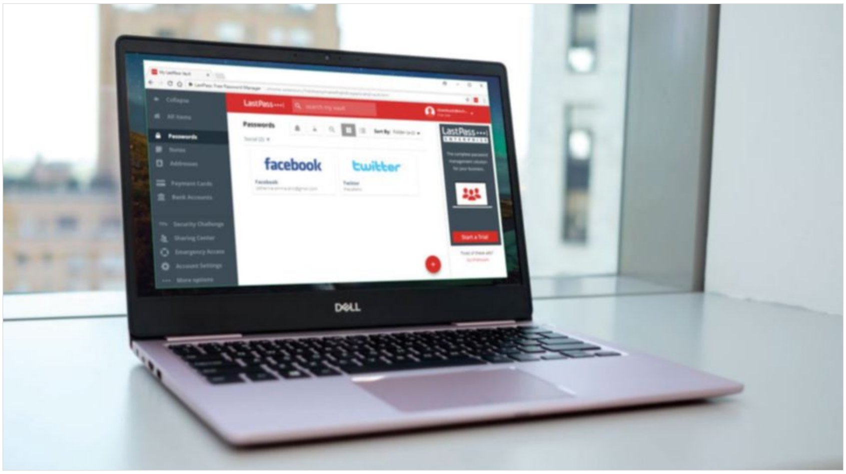
Among many things, it shows that password creation is a truly gender neutral pursuit—men and women can live equally in a world with terrible passwords. It's worth a read—as well as being funny and interesting, it highlights a lot of general failings of humans when it comes to creating passwords.

The obvious beginnings are the standard bad passwords: "123456," and any variation thereof, "password," "qwerty," and again any variation of those. Obvious stuff. Another issue is that many password guidelines are bad—forcing upper-case letters, for instance, because people tend to just capitalize the first letter; forcing at least one number, because people just put "1" at the end; or demanding a password of at least a certain length, because people use a pattern on the keyboard. For example, the seemingly random "ADGJMPTW" is actually people typing 2–9 on a smartphone number pad. This is what happens; it doesn't make for strong passwords, because they're easier to guess with a much lower entropy.

It's that human nature thing. One group wants to protect a system, another wants an easy life, so it circumvents the rules, a third group is attempting to break in. So, how do we make stronger passwords?

A few years ago, a Dropbox engineer, Dan Wheeler, wrote a blog post (https://blogs.dropbox.com/tech/2012/04/zxcvbn-realistic-password-strength-estimation) referencing Randall Munroe's classic XKCD correcthorsebatterystaple cartoon (https://xkcd.com/936) on password entropy, alongside Mark Burnett's earlier research (https://xato.net/perilous-password-policies-3ad038aa33b1). Dan's post is long and complex, and focuses on what makes a strong (high entropy) password, alongside how that can be easily measured and communicated to the user. Conversely, Randall's point was part password strength, but he was largely extolling the need to make password systems human-friendly.

We don't want to get into the nitty-gritty too much, but effectively a good password is a long password. Simple. The XKCD approach is to use a memorable series of words or phrase, usually painting an odd scene, such as the classic example of a "correct horse battery staple," but it could be a phrase such as "basketball on



Most password managers work through a browser plugin, as that's where we all live now.

a unicycle flying high." From a memorable point of view, this taps into techniques used by memory experts. Of course, throw in some numerals and symbols, and it's even stronger.

None of this addresses the core issue, though, that we now have a seemingly endless number of online services to use and try, each with their own password and login. Even making passwords memorable wouldn't solve the innate issue of having to remember them all. The solution to that is a password manager.

MICROSOFT SAVE US!

The obvious place to start is to ask what tools Microsoft provides in Windows 10 or beyond. The blasé answer is none. Windows doesn't come with any specific password management tool. What Microsoft has done is build a basic password manager into its Edge browser, which enables those saved passwords to be synchronized across your Windows accounts, and to any other instances of the Edge browser you might be running—Edge on Android, for example. But what if you're not on your Windows account? What if you're not on Windows at all? What if you're using Chrome or Firefox? What if you want to create a strong password? What if a site is demanding non-standard credentials? The Edge password manager is basic at best, and fails to help in all but the most simple of scenarios.

BROWSERS SAVE US!

How about a browser that you might actually want to use? The most widely used browser at the moment is Google Chrome, and it comes with a reasonable password manager built in. To kick off, if you've logged in with your Google account, it syncs passwords across all of your devices and operating systems (Windows, MacOS, Linux, Chrome OS), and is, of course, available on Android and iOS devices, too. Google also offers an online service at http://passwords.google.com that enables you to log in and access passwords from within any browser on any device.

Beyond passwords, Chrome also supports intelligent form filling. You can enter a default address, phone number, and email address, and if Chrome thinks you're filling those details in, it offers to try to auto-fill entire forms or individual elements. Alongside this it has a secure credit card storage option, if you find the idea of Google having your credit card details a good one.... What could go wrong?

Chrome's basic but smart enough password manager means that as long as you're logged in to your Google account, a right-click in a password field offers the option to generate a secure password. There are no options, it just provides a random password of suitable length. It then, of course, saves and manages that login and password for you. You can set exceptions and manage the saved passwords from within the "Advanced Settings." Access to these is protected via a system prompt to enter your Windows password.

The other main browser worth a mention is Mozilla Firefox, although it doesn't provide

airbnb
amazon
Aol.
box

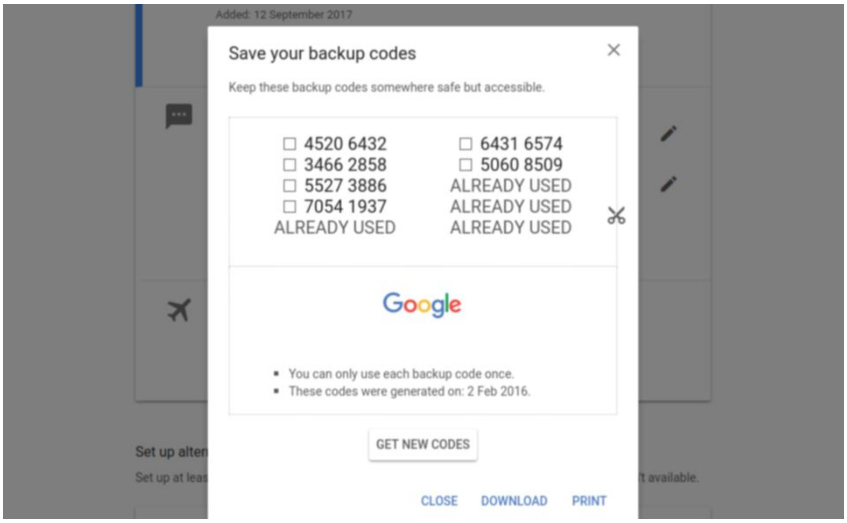
ALTERNATIVE MANAGERS

We're going to suggest three other commercial password managers—the ones that crop up most often, and generally offer similar features at similar costs. So, it's down to you which you feel works the best. The first is 1Password.com; prices start at $2.99 per month for a single user, and $4.99 for a family account for four people.

DashLane is a major player and offers a number of plans that will suit a wide range of consumer and business uses. The basic plan is free for all, but is limited to working on a single device. The paid home plan is $3.33 a month, and supports unlimited devices, password sharing, and Yubikey TFA support. A business plan starts at $4 per user, and includes remote management, group sharing of passwords, and enhanced TFA options, among other things.

Our final option is Keepersecurity.com. It has a similar structure to DashLane, but opts to have yearly subscription pricing. The basic single-user package is $29.99, effectively $2.50 per month, and offers unlimited devices with sync, unlimited password storage, secure cloud backup, fingerprint access, and web access with support. A family option costs $59.99 for five users.

There are, of course, a host more password managers. You can find a vaguely independent list on Wikipedia at https://en.wikipedia.org/wiki/List_of_password_managers, or our sister website TechRadar maintains a list of free(ish) password managers at www.techradar.com/1325845.



Added: 12 September 2017

Save your backup codes

Keep these backup codes somewhere safe but accessible.

☐ 4520 6432
☐ 3466 2858
☐ 5527 3886
☐ 7054 1937
ALREADY USED

☐ 6431 6574
☐ 5060 8509
ALREADY USED
ALREADY USED
ALREADY USED

- You can only use each backup code once.
- These codes were generated on: 2 Feb 2016.

One-time use access codes enable emergency access if you lose your TFA device.

much more functionality than Microsoft Edge. It synchronizes your password across its own Firefox account to any supported OS or devices. It doesn't support forms, won't generate passwords for you, but does offer an independent master password to protect access.

LASTPASS SAVE US!

So, browsers generally leave us wanting more when it comes to real password management. You could get by with Google Chrome, but we can do better. Enter the world of dedicated password managers. We're going to concentrate on LastPass in this main section—for alternatives, see the various boxes throughout the feature. It's certainly one of the prime options to look at when it comes picking a password manager; the free account provides the majority of the basic functions people require, while the paid-for premium edition is just $2 per month.

LastPass is a multi-device, multi-OS, multi-browser tool. It largely works as a browser plugin for the big five: Chrome, Firefox, Safari, Edge/Internet Explorer, and Opera. It runs on all the main desktop OSes: Windows, macOS, Linux, and OpenBSD. And for mobile devices, there's Android, iOS, and Windows Phone support. Plus, you can log in to your LastPass password vault through any browser, too.

The name LastPass comes from the fact that your LastPass account password will be the last password you need to remember; it'll take care of all the rest. So, what does it do? The main use is via a browser plugin and apps on your mobile devices. As you create new accounts or log in to existing ones, LastPass stores your usernames and passwords, or offers to generate new passwords as accounts are created.

The LastPass password generator is pretty sweet. You can choose any length, up to 100 characters, select any mix of upper and lower-case, choose the quantity of numbers to use, and decide if it should use symbols. There are also advanced options for avoiding ambiguous symbols or attempting to make it pronounceable.

Accounts can be grouped into categories and searched. You can add notes and opt for automatic logins, to help speed you into accounts. LastPass also supports automatic filling of standard forms: names, addresses, emails, phone numbers, bank accounts, credit cards, and custom fields. There's a general encrypted notes tool, too. It also offers a warning for insecure forms, plus a security audit of existing

THE OPEN-SOURCE WAY

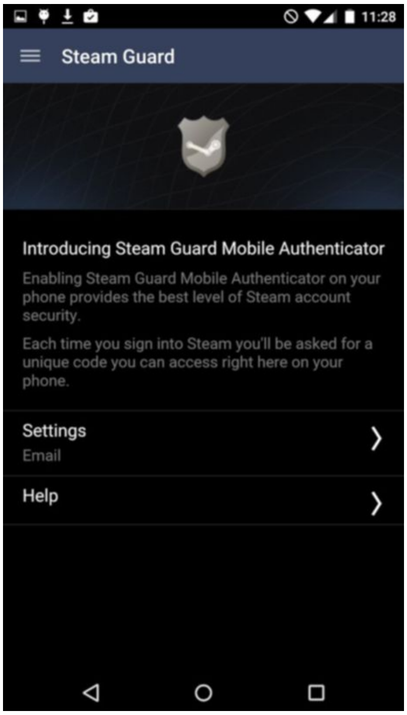
bitwarden
Sync and access your vault from multiple devices

We like open source; it might not always produce the most polished-looking software *[cough]* GIMP *[cough]*, but for security software, its publicly scrutinizable code tends to provide peace of mind, while largely ensuring a project can continue even if the original organization or developer packs up their bags, as the source code stays open to be picked up by someone else.

We're going to highlight two strong open-source candidates. The first is the well-known KeePass.info. Don't confuse this with the largely defunct KeePassX.org that hasn't been updated for two years. There is a fork called KeePassXC.org, which is up to date, but we'll stick with KeePass as it has many unofficial respins for Android and other devices that make it easier to use.

KeePass isn't as straightforward to use as the commercial alternatives; the main hoop you need to jump through is for multi-device synchronization, where a third-party cloud service, such as Dropbox or Google Drive, needs to be roped in. But the breadth of support, custom options, and feature set is unmatched, with no fees to pay.

The other strong open-source option is Bitwarden. It offers an excellent free model, a $1-a-month family subscription that supports up to five users, a basic business version at $5 per month, plus enterprise options. It's a modern, slick, open-source application supporting macOS, Windows, Linux, all the major browsers—including Opera, Tor, and Brave—plus Android and iOS devices. If you're a fan of open source, we suggest you give it a look.



Introducing Steam Guard Mobile Authenticator

Enabling Steam Guard Mobile Authenticator on your phone provides the best level of Steam account security.

Each time you sign into Steam you'll be asked for a unique code you can access right here on your phone.

Steam has offered secondary authentication for many years.

accounts that you might import from your browser. Two-factor authentication is supported, too (we cover this later). The paid-for service expands password filling to other applications, on both Android and Windows—LastPass can fill in a program's password and fields; handy these days as more programs require some type of login for subscriptions.

Once installed, it's worth looking at the "Preferences." We like to add a log-out time, so if you leave your PC alone, it logs itself out after an hour, for example.

LastPass isn't the only password manager to offer all these features, but it does provide an idea of the expanded capabilities, improved security, and genuine ease of use a dedicated service offers.

But with great power, comes great responsibility. A service like LastPass requires you to use a strong master password; if that is hacked, someone will gain access to every service you use. Or if you forget the password, LastPass can't restore your master password, as it is never sent it in the first place, as a deliberate security measure. It might sound like we're putting all our eggs in one basket, but what do you want—an individual basket for every egg, or just one awesomely secure basket?

Even security conscious businesses can be hacked and run into issues (https://en.wikipedia.org/wiki/LastPass#Security_issues). LastPass has had a number of vulnerabilities exposed, and even had a successful hack attack on its own servers in 2016. But as a security conscious company should, LastPass offers bug bounties—which it honors—and is open about breaches with its users, while using best practice on its secure storage. So even the server breach in 2016 meant users' own passwords remained secure.

GABEN SAVE US!

A question that security experts started to ask a while ago was: Is there anything better than passwords? You won't like the answer, but it's unlikely we'll ever be completely free from passwords, though two-factor authentication offers a respite. Called TFA for short, the premise is that people require two forms of identification, aka authentication; typically, the first is a strong password (something you know), and the second can be your fingerprint, your delightful face, or a generated one-time-use passcode (something you have).

As you might have spotted, many phones are now using fingerprints and face scans to authenticate access. Financial institutes are even happy enough that NFC-equipped phones can authenticate credit card transactions. Some systems (LastPass, VeraCrypt) accept USB thumb drives and specialist USB keys (Yubikey, www.yubico.com) as a second form of authentication.

Steam is a good example of a service that was quick to provide two-factor authentication. You should be familiar with its email verification, which sends a code to your default email address, while more recently, Valve introduced the Steam Authenticator app, which is required if you're messing around with its trades. ⏻

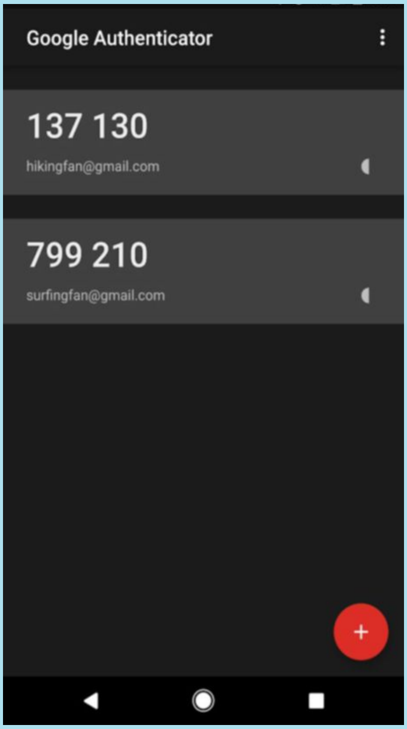
AUTHENTICATE WITH GOOGLE

We're going to highlight the Google Authenticator as a prime TFA tool. Install it on your phone, then fire up the service you want to protect with TFA. LastPass uses Google Authenticator (among others) to do so. Using that as an example, head to "LastPass Vault → Account Settings → Multifactor options." Click the "Edit" button and "Enable" it. Use the "Barcode" option to display a QR code. On your phone, open Google Authenticator, tap the "+" and click "Scan barcode," then point your phone at the on-screen QR code. LastPass has now been added to Google Authenticator.

Anytime someone tries to access your LastPass Vault from a new device, they must enter the current code (this updates every 30 seconds) before access is granted. There's an option to allow access for 30 days, before another TFA prompt appears on that device, so it's not too annoying. Without your phone, there's no access.

TFA is great, but does have a couple of provisos. Firstly, the service using it mustn't be monumentally stupid. It was discovered that some services could have TFA circumvented by simply calling up and providing some basic personal information, making the use of TFA more security theater than actual security. The second is that potentially the TFA code is locked to the one phone. Technically, a rooted Android device enables you to transfer the Google Authenticator secrets, but if you get a new phone, ensure you disable TFA on your services, before wiping your old one. Otherwise, you could be locked out of vital services. LastPass keeps the QR code secret, so you can have it on multiple devices, and transfer it later on—as long as you can log in.

Because of the magical nature of cryptography math, many services also offer offline access options, usually via a bank of single-use passcodes that you can print or scribble down, and keep safe somewhere. It means if your phone is stolen or broken, you can still access accounts.



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PLAY WINDOWS GAMES IN LINUX

Discover how to get classic Windows games working in Ubuntu with *Nick Peers*

GAME DEVELOPERS are increasingly taking advantage of the growing market in Linux gaming, but that's not always been the case, and even now some games aren't released outside of Windows. Thanks to a clever tool called Wine, though, you can run many Windows games—and other apps, including Office—as though they were native to Linux.

Wine provides a skeletal virtual version of Windows, inside which you install extra components and perform various tweaks (for example, selecting which version of Windows you want to emulate) to get your app working. Sadly, it's not a silver bullet that will get all your Windows games working in Linux, but it should be able to give you access to at least some of them.

The biggest hurdle is that Wine is a command-line tool—great for purists; not so convenient if you want to point and click your way to gaming heaven. Thankfully, others have developed graphical "wrappers" that sit on top of Wine to make it easier to use from the Ubuntu desktop.

In this guide, we're focusing on one such free tool called PlayOnLinux. Not only does it provide a graphical front end, but PlayOnLinux (or POL to its pals) provides a series of pre-built scripts that, in theory, make it easy to install and play specific games. As you'll see, in practice that's not always the case, but we'll take you on a tour of the program's features, plus step you through the process of installing both through scripts and manually, to hopefully get your game up and running.

We'll also explore an alternative Wine wrapper (and touch on another way to play Windows games in Linux), plus reveal how to play old DOS games in addition to Windows classics. So, plug in your game controller, dig out your old Windows discs, and prepare to enter gaming nirvana.

NZXT

For the most part, playing Windows games in Linux involves the Wine emulator. PlayOnLinux (POL) is effectively a more user-friendly front end to Wine, enabling you to configure and access it from outside the command line. Generally, Windows games are played in a 32-bit environment, so if you're running a 64-bit build of Linux, you need to open a Terminal window, and then issue the following commands:

```
$ sudo dpkg --add-architecture i386
$ sudo apt-get update
```

The following steps install the latest version of Wine:

```
$ wget -nc https://dl.winehq.org/wine-builds/Release.key
$ sudo apt-key add Release.key
$ sudo apt-add-repository https://dl.winehq.org/wine-builds/ubuntu/
$ sudo apt-get update && sudo apt-get install --install-recommends winehq-stable
```

Note: This is a hefty install—around 800MB—so make sure you have sufficient drive space. Once done, you can move on to install POL itself:

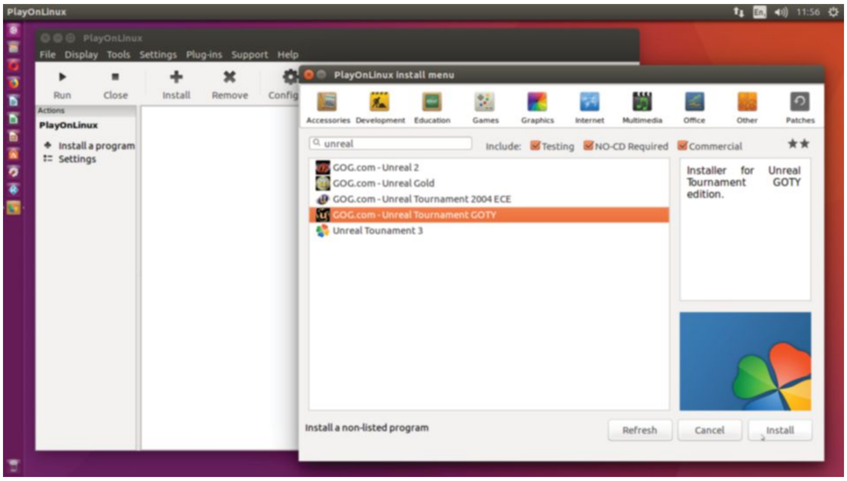
```
$ wget -q "http://deb.playonlinux.com/public.gpg" -O- | sudo apt-key add -
$ sudo wget http://deb.playonlinux.com/playonlinux_trusty.list -O /etc/apt/sources.list.d/playonlinux.list
$ sudo apt-get update && sudo apt-get install playonlinux
```

Open Launcher and type "PlayOnLinux" to launch the app. When prompted, we recommend clicking "Yes" to anonymously record and share your hardware configuration with POL the first time you attempt to run a Windows program—this helps determine its suitability for similar setups as yours.

The main screen appears, and you might be immediately informed that a newer version is available—if this is the case, go to www.playonlinux.com/en/download.html and save the latest deb file (4.2.12) to your "Downloads" folder, then open a Terminal window, and type the following to install it:

```
$ sudo apt install ~/Downloads/PlayOnLinux_4.2.12.deb
$ playonlinux --version
```

This should now read "4.2.12." Launch PlayOnLinux again.

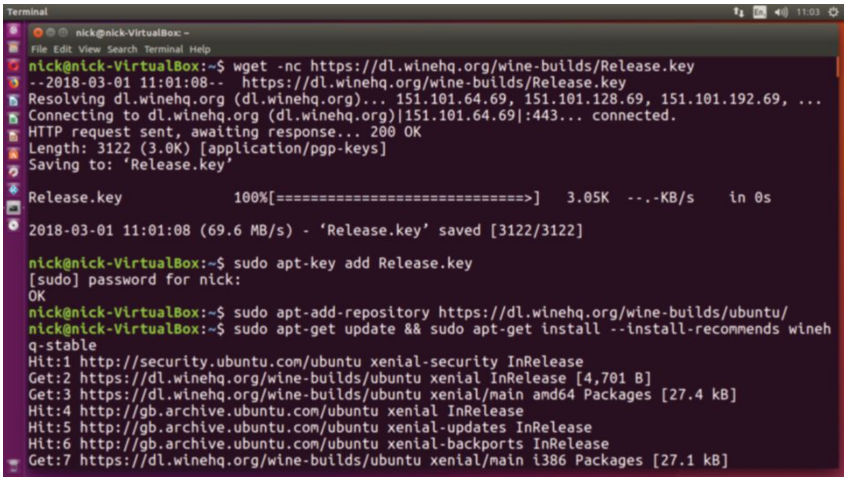


unreal

GOG.com - Unreal 2
GOG.com - Unreal Gold
GOG.com - Unreal Tournament 2004 ECE
GOG.com - Unreal Tournament GOTY
Unreal Tounament 3

Installer for Unreal Tournament GOTY edition.

POL provides literally hundreds of scripts for games.



```
nick@nick-VirtualBox:~$ wget -nc https://dl.winehq.org/wine-builds/Release.key
--2018-03-01 11:01:08--  https://dl.winehq.org/wine-builds/Release.key
Resolving dl.winehq.org (dl.winehq.org)... 151.101.64.69, 151.101.128.69, 151.101.192.69, ...
Connecting to dl.winehq.org (dl.winehq.org)|151.101.64.69|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 3122 (3.0K) [application/pgp-keys]
Saving to: 'Release.key'

Release.key            100%[=============================>]   3.05K  --.-KB/s    in 0s

2018-03-01 11:01:08 (69.6 MB/s) - 'Release.key' saved [3122/3122]

nick@nick-VirtualBox:~$ sudo apt-key add Release.key
[sudo] password for nick:
OK
nick@nick-VirtualBox:~$ sudo apt-add-repository https://dl.winehq.org/wine-builds/ubuntu/
nick@nick-VirtualBox:~$ sudo apt-get update && sudo apt-get install --install-recommends wineh
q-stable
Hit:1 http://security.ubuntu.com/ubuntu xenial-security InRelease
Get:2 https://dl.winehq.org/wine-builds/ubuntu xenial InRelease [4,701 B]
Get:3 https://dl.winehq.org/wine-builds/ubuntu xenial/main amd64 Packages [27.4 kB]
Hit:4 http://gb.archive.ubuntu.com/ubuntu xenial InRelease
Hit:5 http://gb.archive.ubuntu.com/ubuntu xenial-updates InRelease
Hit:6 http://gb.archive.ubuntu.com/ubuntu xenial-backports InRelease
Get:7 https://dl.winehq.org/wine-builds/ubuntu xenial/main i386 Packages [27.1 kB]
```

You only need the command line to install Wine and PlayOnLinux.

INSTALL A SUPPORTED GAME

When the main screen appears again, click "Install a program," and the "Install" menu appears. Click the "Games" button to see a list of supported games. Either browse through the list or use the "Search" button to find a specific game. Some of the games listed require the original disc to run, so make sure that's handy if required.

If you find the game you want, click "Install," and note the warning: Games should always be installed to "drive C" of the virtual machine; don't automatically launch the game at the end of the installation if asked; and only reboot virtual Windows if asked to by the program. Click "Next."

You're also told how POL isn't related to WineHQ—one additional advantage of POL is that it allows you to install and run multiple versions of Wine at the same time, so if an earlier version is known to work with a specific game, the POL script installs that, and uses it automatically. This warning merely points out you should address any problems you encounter to the POL website, not WineHQ. Click "Next" again.

The installation wizard proper launches—work your way through it as you would with any other Windows program. Step one may be to download a specific version of Wine (and required prerequisites) known to work with the game you've chosen—this is done automatically for you.

Next, you might be prompted to choose the game source. This could be a setup file you've downloaded manually to your PC, a program download (which POL handles for you), a Steam store version (in which case, a virtual version of Steam needs to be installed), or the original game CD.

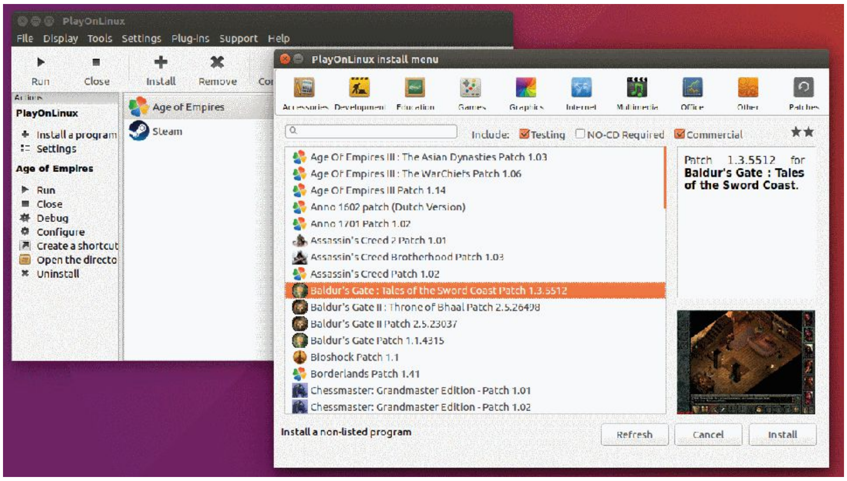
Any known additional prerequisites—such as Microsoft fonts—are now flagged up, and again installed automatically for you. This is where the automatic wizard comes into its own, highlighting settings and Windows elements you may not be aware of. You might also be asked additional questions, such as how much memory your graphics card has; enter the following in a Terminal window if you're not sure.

```
sudo dmesg | grep drm
```

If the script continues to run properly, skip to "Install the game" on page 46.

FIND AN UNSUPPORTED GAME

If you can't find your game listed in PlayOnLinux—or the script fails to work (see the box opposite for a workaround involving Steam-powered


PlayOnLinux
File Display Tools Settings Plug-ins Support Help
Run Close Install Remove
PlayOnLinux
Install a program
Settings
Age of Empires
Run
Close
Debug
Configure
Create a shortcut
Open the directo
Uninstall
Age of Empires
Steam
PlayOnLinux install menu
Accessories Development Education Games Graphics Internet Multimedia Office Other Patches
Include: ☑ Testing ☐ NO-CD Required ☑ Commercial
Age Of Empires III : The Asian Dynasties Patch 1.03
Age Of Empires III : The WarChiefs Patch 1.06
Age Of Empires III Patch 1.14
Anno 1602 patch (Dutch Version)
Anno 1701 Patch 1.02
Assassin's Creed 2 Patch 1.01
Assassin's Creed Brotherhood Patch 1.03
Assassin's Creed Patch 1.02
Baldur's Gate : Tales of the Sword Coast Patch 1.3.5512
Baldur's Gate II : Throne of Bhaal Patch 2.5.26498
Baldur's Gate II Patch 2.5.23037
Baldur's Gate Patch 1.1.4315
Bioshock Patch 1.1
Borderlands Patch 1.41
Chessmaster: Grandmaster Edition - Patch 1.01
Chessmaster: Grandmaster Edition - Patch 1.02
Patch 1.3.5512 for Baldur's Gate : Tales of the Sword Coast.
Install a non-listed program
Refresh Cancel Install

Check for patches after installing your games.

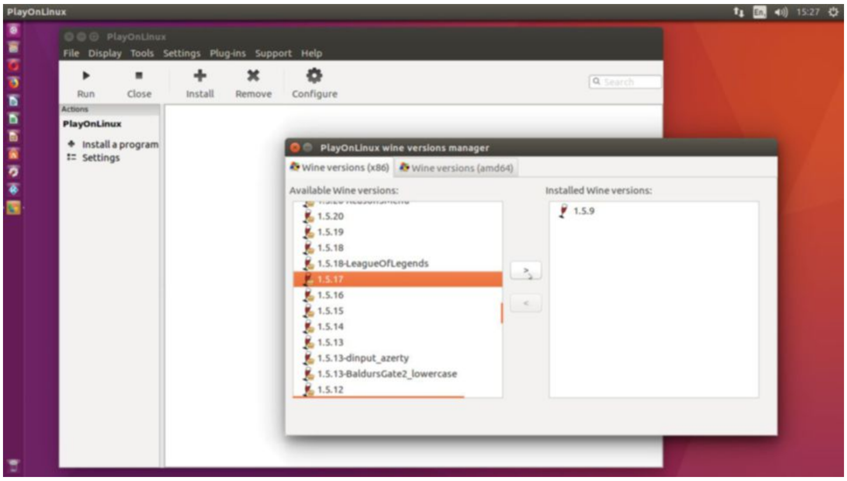
games)—don't panic (yet). Head to the Wine Application Database at https://appdb.winehq.org and type the name of your game into the Search box. Scroll down, and click the first AppDB result. Note the game's rating: Platinum and Gold indicate the game should work with few problems; Silver and Bronze suggest there may be issues, such as random crashes; Garbage means it won't work. If multiple versions are listed, choose the one closest to your distro and the game.

From here, work through the "Test Results" and "Known Bugs" to see how other people have fared, then expand "HowTo/Notes" to see what guidance there is in terms of prerequisites, which version of Wine to choose, and so on. Also check "Comments" for further information.

In some cases, you receive detailed instructions on what extras to install and how to configure your virtual disk, but sometimes the notes are incredibly sketchy. Try Googling the name of your game along with "Wine" or "PlayOnLinux" to see if you can find any more information—typically via forum posts from people asking the exact same questions you are.

If you're happy there's a good chance the game will work, first make sure you have the correct version of Wine installed (you can install multiple versions). In PlayOnLinux, open the "Tools" menu, and select "Manage Wine Versions." You'll see a list of available Wine versions on the left under the "Wine versions (x86)" tab. Scroll through, finding the one recommended, and click the ">" button to install it.

Close the versions manager window, then click "Install a program," followed by "Install a non-listed program." Click "Next," then choose "Install a program in a new virtual drive," and click "Next" again. Give a name for your game's virtual drive—the game's name should suffice. You're given three optional choices to select: Choose a different version of Wine; configure Wine; and install some libraries. Select those you'll need—"Use another version of Wine" almost certainly—then click "Next." If you're choosing a different version of Wine,


PlayOnLinux
15:27
PlayOnLinux
File Display Tools Settings Plug-ins Support Help
Run Close Install Remove Configure
Search
Actions
PlayOnLinux
Install a program
Settings
PlayOnLinux wine versions manager
Wine versions (x86)
Wine versions (amd64)
Available Wine versions:
Installed Wine versions:
1.5.20
1.5.19
1.5.18
1.5.18-LeagueOfLegends
1.5.17
1.5.16
1.5.15
1.5.14
1.5.13
1.5.13-dinput_azerty
1.5.13-BaldursGate2_lowercase
1.5.12
>
<
1.5.9

POL enables you to run multiple versions of Wine at once.

INSTALL STEAM IN POL

PlayOnLinux's scripts aren't always capable of getting the job done, sadly. There's a particular issue with Steam-powered games, where the installer falls over attempting to insert Steam into the virtual drive you've created. The solution here is to install Steam directly first, using the POL script—after it's successfully installed, double-click the icon, and allow it to update itself. If you receive an error saying it's crashed, but a progress bar is still running, leave it to finish updating, then click "Next" to remove the crash window, and log in to your Steam account.

As things stand, Steam works, but is unable to access the store in Ubuntu 16.04 LTS. To resolve this, first select its shortcut in the main POL window, and then click "Configure." Type the following into the "Arguments" box on the "General" tab.

```
-no-cef-sandbox
```

(This constitutes a security risk, just so you know.) Now switch to the "Install Components" tab, and install the following elements: d3dx9_42, vcrun2008, and xact. You also need to install vcrun2015, but it's not present. Instead, switch to the "Miscellaneous" tab, and click "Open a shell." Now type the following commands into the shell:

```
$ wget https://raw.githubusercontent.com/Winetricks/winetricks/master/src/winetricks
```

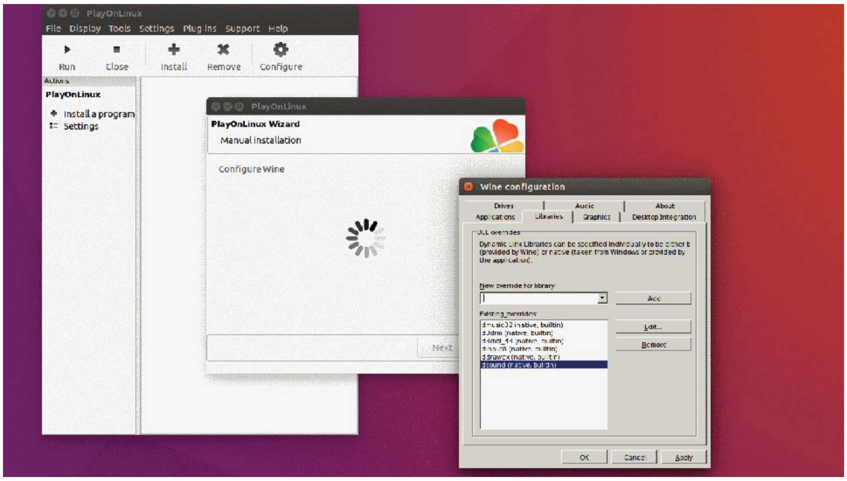
```
$chmod +x winetricks
```

With the following command, substitute "username" with your own username:

```
$ WINEPREFIX=/home/username/.PlayOnLinux/wineprefix/Steam ./winetricks -q vcrun2015
```

After running, it appears to throw up an error. No matter—close the window, and relaunch Steam. After downloading another update, you'll finally have access, enabling you to download and try to run any games you've purchased.

Play Windows Steam games with POL.


PlayOnLinux
File Display Tools Settings Plug-ins Support Help
Run
Close
Install
Remove
Configure
Actions
PlayOnLinux
Install a program
Settings
PlayOnLinux
PlayOnLinux Wizard
Manual installation
Configure Wine
Next
Wine configuration
Drives
Audio
About
Applications
Libraries
Graphics
Desktop Integration
DLL overrides
New override for library
Add
Existing overrides
Edit...
Remove
OK
Cancel
Apply

Dynamic Link Libraries can be specified individually to be either b (provided by Wine) or native (taken from Windows or provided by the application).

dmusic32 (native, builtin)
d3drm (native, builtin)
d3dx9_43 (native, builtin)
dinput8 (native, builtin)
ddrawex (native, builtin)
dsound (native, builtin)

Configure your virtual desktop using the Wine configuration dialog box.

select it from the list. Click "Next." Leave "32-bit Windows installation" selected, and click "Next" again.

If you opted to install additional libraries, you're given a list of options marked with a "POL_" prefix. They're largely self-explanatory—you'll see many refer to installing additional components, such as DirectX or GDIplus, for example.

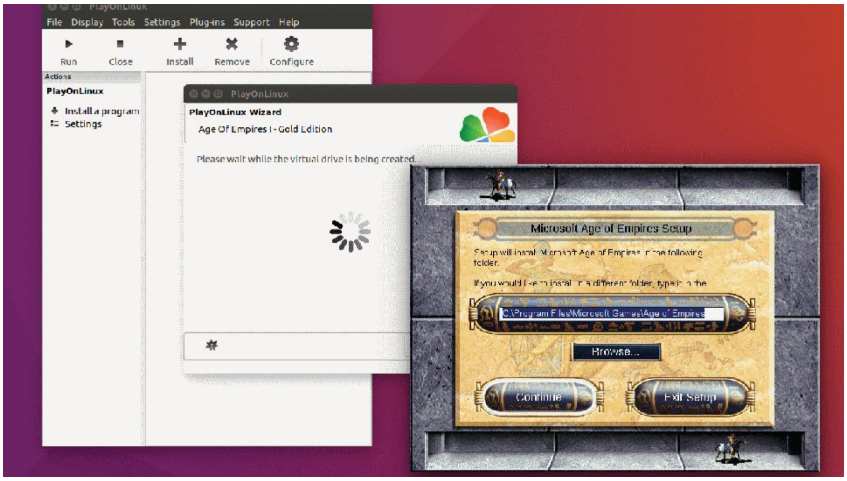
If you opt to tweak Wine settings, the Wine configuration window opens. This is split into seven tabs, all of which are largely self-explanatory. Key ones to consider are "Libraries," where you can specify DLL overrides for compatibility purposes; "Graphics," for determining whether the program runs full-screen or in its own desktop window; and "Audio," for tweaking sound settings, should you need to. Click "OK" when done.

INSTALL THE GAME

Whether you're installing from a script or manually, the actual game setup process is the same. Hopefully, your CD or DVD will be automatically detected, otherwise click the "Browse" button to locate your game's setup file—if it's on CD or DVD, select the disc in the "Places" menu. Locate the file you need to run—try setup.exe if there's no guidance from the AppDB—and click "Open," then "Next." PlayOnLinux now tries to install the game.

You should see a setup screen from the program itself, which is actually running inside the virtual drive POL created—in other words, proof your skeletal version of Windows is up and running. From here, it's a case of following the game's own wizard through to see whether it's able to complete successfully—leave the default file location selected when prompted. If errors are thrown up, you may find the game still runs, so attempt to continue to the end if possible by clicking "Next."

If successful, you're prompted to choose a file that PlayOnLinux will use as a shortcut—select it from the list, or click "Browse" if none is provided to hunt your virtual drive for one. It uses the Windows


PlayOnLinux
File Display Tools Settings Plug-ins Support Help
Run
Close
Install
Remove
Configure
Actions
PlayOnLinux
Install a program
Settings
PlayOnLinux
PlayOnLinux Wizard
Age Of Empires I - Gold Edition
Microsoft Age of Empires Setup
Browse...
Continue
Exit Setup

Please wait while the virtual drive is being created...

Setup will install Microsoft Age of Empires in the following folder.

If you would like to install in a different folder, type in the

C:\Program Files\Microsoft Games\Age of Empires

Games are installed just as they would be in Windows.

PLAY DOS GAMES

Ever wanted to revisit classic games from the '90s? DOSBox enables you to play games written for MS-DOS, and while it's possible to tie it into PlayOnLinux, it's far simpler to just install it natively:

```
$ sudo apt-get install dosbox
$ mkdir -p ~/dos/c
```

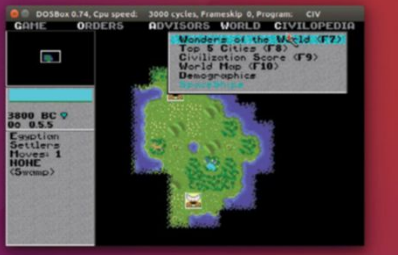
DOS games reside in their own folder, and you can source a wide variety from www.abandonia.com. Download a game in Zip format to your Downloads folder, then extract its contents into the dos/c folder you created in your Home folder.

Now type "dosbox" and hit Enter to launch DOSBox in its own window. Next, enter the following command for it to mount your /dos/c folder as its own C drive:

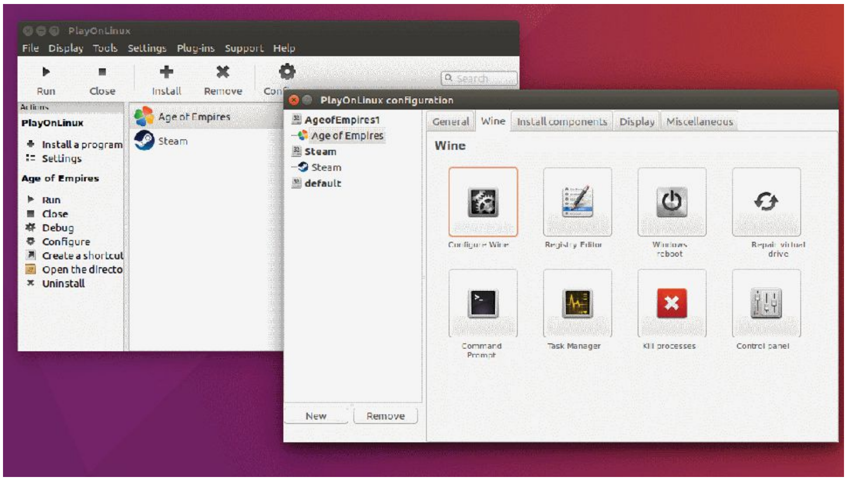
```
$ mount c /home/username/dos/c
$ c:
```

Type "dir" and hit Enter to verify you're in the correct spot—you'll see folders for each of the games you want to run. Type "cd dirname" (for example, "cd civ1" for *Civilization*) to switch directory to the folder, then type "dir" again to identify the game file itself ("civ" in the case of our *Civilization* example). Finally, type the file name, and hit Enter to launch—and play—the game.

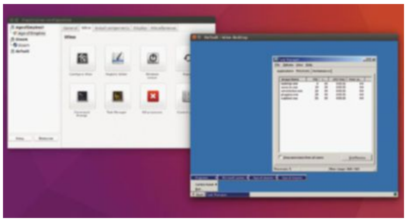
If prompted, choose "VGA (256 colors)" for graphics, and "SoundBlaster" for sound. DOSBox should also work with any basic USB controller recognized by Linux, as well as your mouse and keyboard. When you click inside the DOSBox window, your mouse will be captured permanently—press Ctrl-F10 to release the mouse back to the main desktop, and visit www.dosbox.com for a full guide to playing DOS games on your PC.


DOSBox 0.74, Cpu speed: 3000 cycles, Frameskip 0, Program: CIV
GAME ORDERS ADVISORS WORLD CIVILOPEDIA
Wonders of the World (F7)
Top 5 Cities (F8)
Civilization Score (F9)
World Map (F10)
Demographics
3800 BC
00 0.5%
Egyptian
Settlers
Moves: 1
NONE
(Swamp)

Revisit the '90s with DOSBox.


PlayOnLinux
File Display Tools Settings Plug-ins Support Help
Run
Close
Install
Remove
Search
Actions
PlayOnLinux
Install a program
Settings
Age of Empires
Run
Close
Debug
Configure
Create a shortcut
Open the directory
Uninstall
Age of Empires
Steam
PlayOnLinux configuration
AgeofEmpires1
Age of Empires
Steam
Steam
default
General
Wine
Install components
Display
Miscellaneous
Wine
Configure Wine
Registry Editor
Windows reboot
Repair virtual drive
Command Prompt
Task Manager
Kill processes
Control panel
New
Remove

You can tweak your virtual desktop via a series of tabs.



Run games inside their own virtual desktop window if necessary.

filesystem, so start your search under C:\Program Files. Once done, you're prompted to add as many additional shortcuts as you need. Leave "I don't want to make another shortcut" selected, and click "Next" when you're done.

These shortcuts appear on both your desktop and the main PlayOnLinux window; the former enables you to launch your game without having to open PlayOnLinux first, but can be safely deleted without removing the others. You can recreate desktop shortcuts from the main PlayOnLinux window by selecting a shortcut and clicking "Create a shortcut" in the left-hand pane.

THE MOMENT OF TRUTH

It's time to see how your game plays—if you've installed it manually using a guide from AppDB, you should have forewarning about any potential issues, but your experience may be different. Double-click the shortcut, which should launch the game directly or open Wine Explorer (in which case, click the shortcut again). The game will hopefully launch, and you can start playing it. In most cases, however—and particularly if you've installed it manually—things won't be quite that simple, in which case, you may need to dig deeper into your virtual drive's configuration.

First, the game may change your desktop resolution to 640x480, and not reset after it's finished (or crash, leaving you stuck with only the top-left corner of your screen showing). To restore your original desktop resolution, press Ctrl-Alt-T to open a Terminal window, then type the following, and hit Enter:

```
$ xrandr -s 0
```

The screen blanks momentarily, and your default resolution is restored. To prevent this happening again, try running the game in a virtual window: Click "Configure," select your virtual drive, and switch to the "Wine" tab. Click "Configure Wine," and wait for the Windows-like multi-tabbed window to appear. Switch to the "Graphics" tab, and select "Emulate a virtual desktop," then set it to the game's resolution: 640x480, 800x600, or 1024x768 in most cases, depending on the game's age.

The POL configuration window also offers more configuration options—the "Wine" tab gives you access to your virtual drive's Task Manager, Control Panel, and a Kill Processes option, if you're having trouble shutting it down, for example. Return to the "General" tab to run arguments when launching your game. The "Install components" tab enables you to install more Windows components if necessary, while "Display" enables you to experiment with various settings that may or may not fix display glitches. Finally, "Miscellaneous" lets you open a shell to your virtual drive or manually launch a Windows .exe file (a setup file, for example, not covered under "Install components").

As before, these features are quite technical and you're best served by investigating the POL forums and other web resources for help in understanding and using these with specific programs. And if that's too technical, check out the box on the right for an alternative to PlayOnLinux that may not be free, but is simpler to use, better supported, and provides working scripts for a greater number of games.

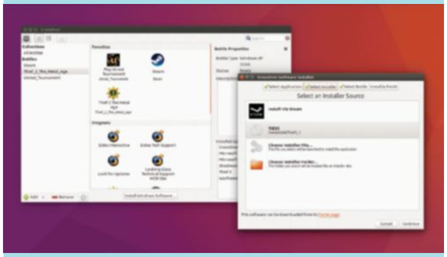
OTHER LINUX GAMING OPTIONS

PlayOnLinux isn't the only way to (try to) run Windows software in Linux. As we've seen, POL is basically a user-friendly wrapper for Wine, and while it makes things easier—particularly in the way it supports multiple Wine versions for compatibility purposes—it's not perfect. As you've seen from the main feature, you'll often be forced to bypass its scripts and attempt to wrestle with its controls—in a more user-friendly interface than offered by Wine itself, though—to try to get your game running.

If the idea of Wine appeals, but spending hours trying to get your game working doesn't, take a look at CrossOver Linux (www.codeweavers.com). Like POL, it's a wrapper for Wine, but it's better developed, because while it's not free, you're paying to support Wine development, and many improvements in Wine have come about through the work of CrossOver's devs.

A trial version is available, giving you ample time to discover whether you'll have more success installing and running your game through CrossOver as opposed to POL—we got *Thief 2* and *Unreal Tournament GOTY* running in CrossOver, for example. The full version can be purchased for $39.95 as a one-off cost, or you can pay $59.95 for 12 months' updates and personal support, to help you try to get your games to run.

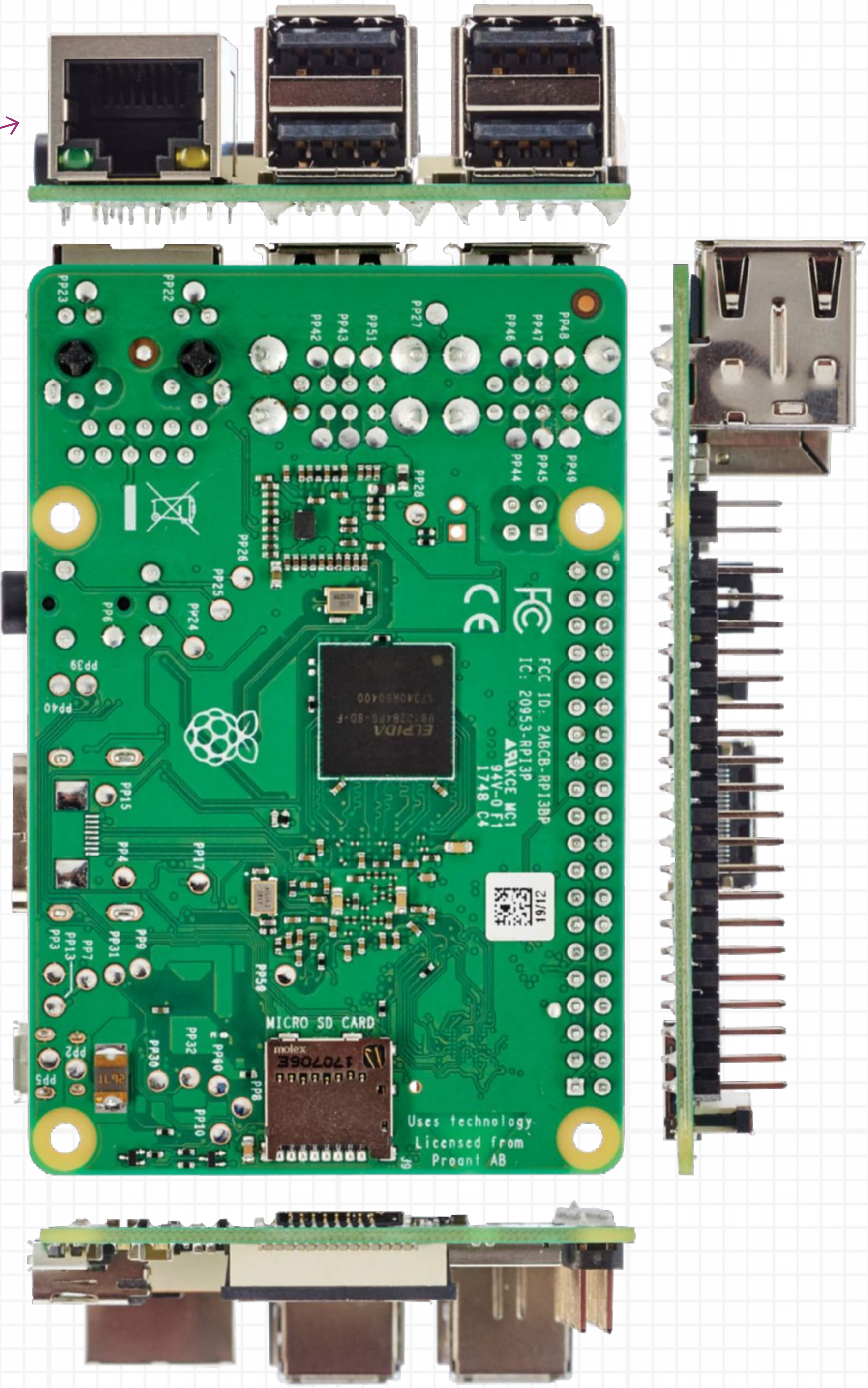
Another workaround can be tried if you have access to a Windows license: Install a virtual Windows machine using VirtualBox (www.virtualbox.org), then install your game in that. Be sure to give it two cores if you can, as well as plenty of RAM—also max out the graphics RAM, and select both 2D and 3D support to give it the best chance of providing reasonable performance for your game.



CrossOver Linux works in a similar way to POL.

TECH PORN

PERFORMANCE GEAR LAID BARE



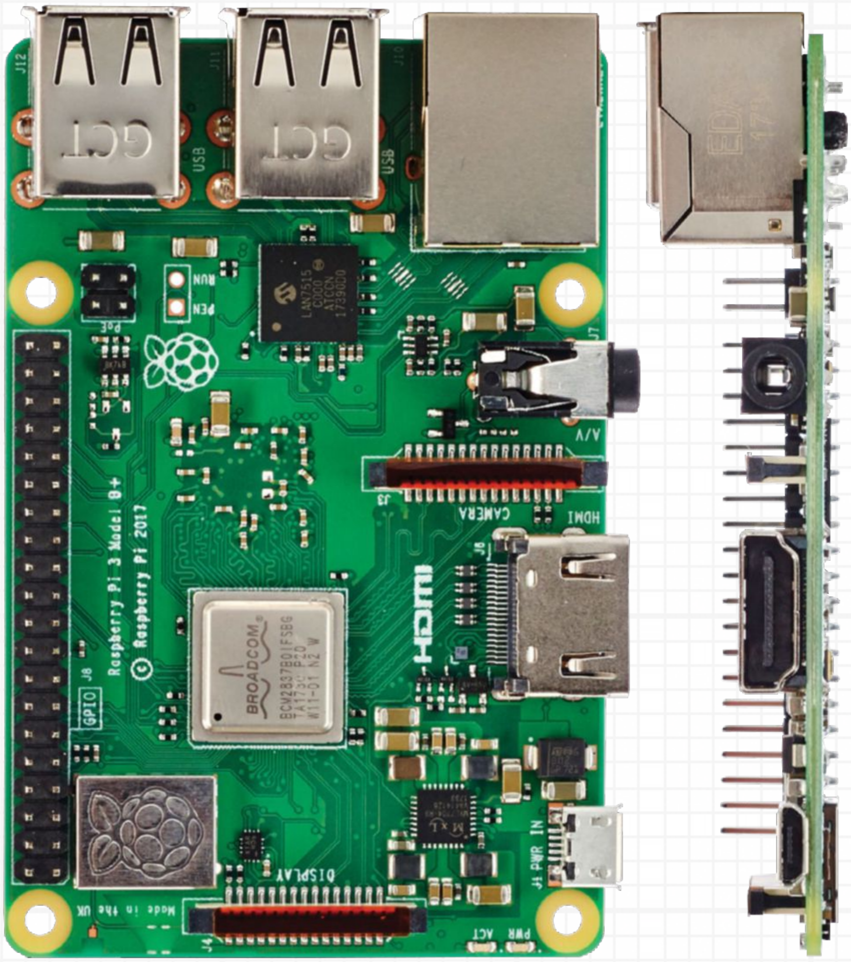
1 Pseudo-G

Wired Ethernet has had an overhaul, with performance increases of two to three times that of previous generations. The Raspberry Pi Foundation refers to this as pseudo-G Ethernet, as it's still bridged over USB 2.0, which means that you're limited to 250–300Mb/s, but on a physical level it's Gigabit Ethernet. This also supports Power-over-Ethernet, and there's a new header for supporting that next to the main GPIO connectors. This will support a new HAT board that will enable you to power your RPi via the Ethernet cable.

2 Wireless Boost

The new Raspberry Pi 3 B+ adds support for 5GHz Wi-Fi to the existing 2.4GHz offering, along with Bluetooth 4.2, and Bluetooth LE. There's a new dual-band Proant antenna squeezed in, drawing on the developments of the RPi Zero W, which was actually a better performer than the RPi 3.

Raspberry Pi 3 Model B+



WHEN WE NORMALLY look at hardware on these pages, it's either because it's aesthetically stunning or so expensive that the vast majority of us can only dream of getting our hands on it. Not so with the latest entry to the Raspberry Pi family. At $35, this mini marvel is well within everyone's financial reach, and to be frank, it probably isn't something you'd want to tear out and stick on the wall of your den. Indeed, the beauty of the RPi 3 B+ isn't on show, but rather what's happening under the surface.

This new revision boasts the same processor as you'd find on the RPi 3, although it's a new package, which means that it now sports a new heatspreader, enabling the core clock be pushed higher, to 1.4GHz as opposed to the last generation's 1.2GHz. The fact that it's still the Broadcom BCM2837 chip means that everything that worked previously still works no problem.

It's worth noting that the new board is much tidier than previous versions, because a lot of the power regulation has been sucked into a new Maxlinear chip that can be found in the bottom right-hand corner, next to the USB power connector. This improved power management is also a contributing factor in the new chip being pushed 200MHz harder.

This is the general ethos of the new Raspberry Pi 3 B+, a lot has been tuned to make for a tighter, leaner device that performs better and even more. –ALAN DEXTER

3 Shield Block

The new antennas are in this shielded module, which means that if you develop something using the Raspberry Pi, you don't have to get the whole device compliance tested, because you can take the work that the Raspberry Pi Foundation has done on the antenna. Great for serious applications.

CB CREATIVE BLOQ

> “There are three responses to a piece of design – yes, no, and WOW! Wow is the one to aim for.

MILTON GLASER

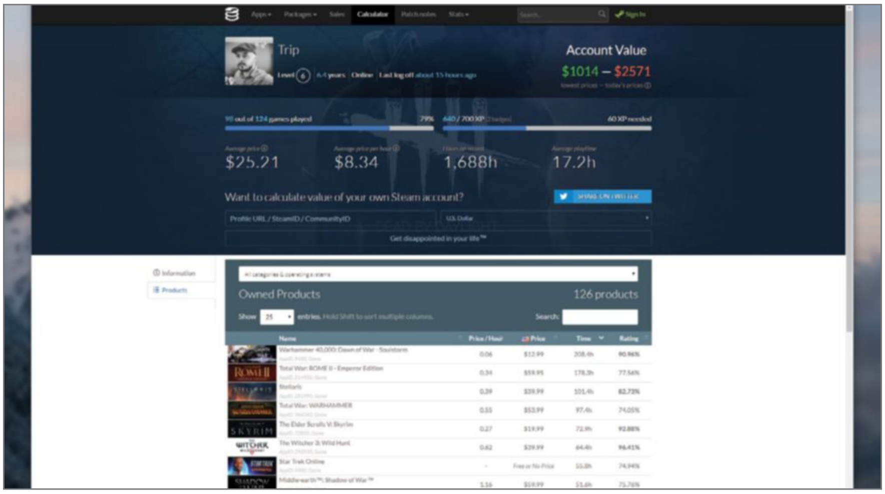
The number one destination for
graphic design news, views, and how-tos

creativebloq.com

HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

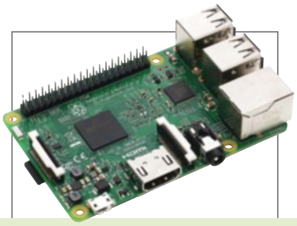
TIP OF THE MONTH



STEAM DB CALCULATOR

If you've ever wondered how much time and money you've spent on your gaming habit, Steamdb.info is the site for you. Enter your Steam profile URL, and it calculates lots of not-so-fun facts about your gaming. To find your profile URL, open Steam, go to "View → Settings → Interface," and select "Display Steam URL address bar when available." Go to your profile, and it's now at the top-left. $Free https://steamdb.info/calculator

MAKE – USE – CREATE



54
Build a Raspberry Pi wireless access point

62
Use Photoshop to tilt-shift like a photographic pro

64
How we constructed competing AMD and Intel budget builds

ZAK STOREY
DEPUTY EDITOR

TECH JOURNO INSIGHT

This job has a funny way of warping your perspective on the cost of things. We receive an excessive level of components here, and over time, when you're exposed to that constant barrage of hardware, you begin to lose appreciation for its value. That's not to say we treat it with disrespect, but because we don't actually buy it, we're often disconnected from its cost.

It's one of the reasons why the Blueprints section at the back of the mag is so important. Not only to you, but to us as well. It gives us a good grounding in what the industry is doing, and how it's affecting consumers. In fact, the big-brass-balled executive editor and myself take turns doing it from issue to issue, just to keep us sharp.

Intriguingly, exposure to excessive levels of tech has the opposite effect when it comes to excitement. As you become swamped by GTX 1080 Tis and 10-core CPUs, true glee typically only occurs when budget-oriented parts arrive. The Core i3s and RX 480s. Amazingly, they are infinitely more difficult to acquire, but far more interesting, too, as you analyze just what architectural wonders have been transposed down to this mainstream, market-holding component.

So, in short, it's the low end, not the high end, that interests us the most. The bang-for-the-buck element, not the balls-to-the-wall.

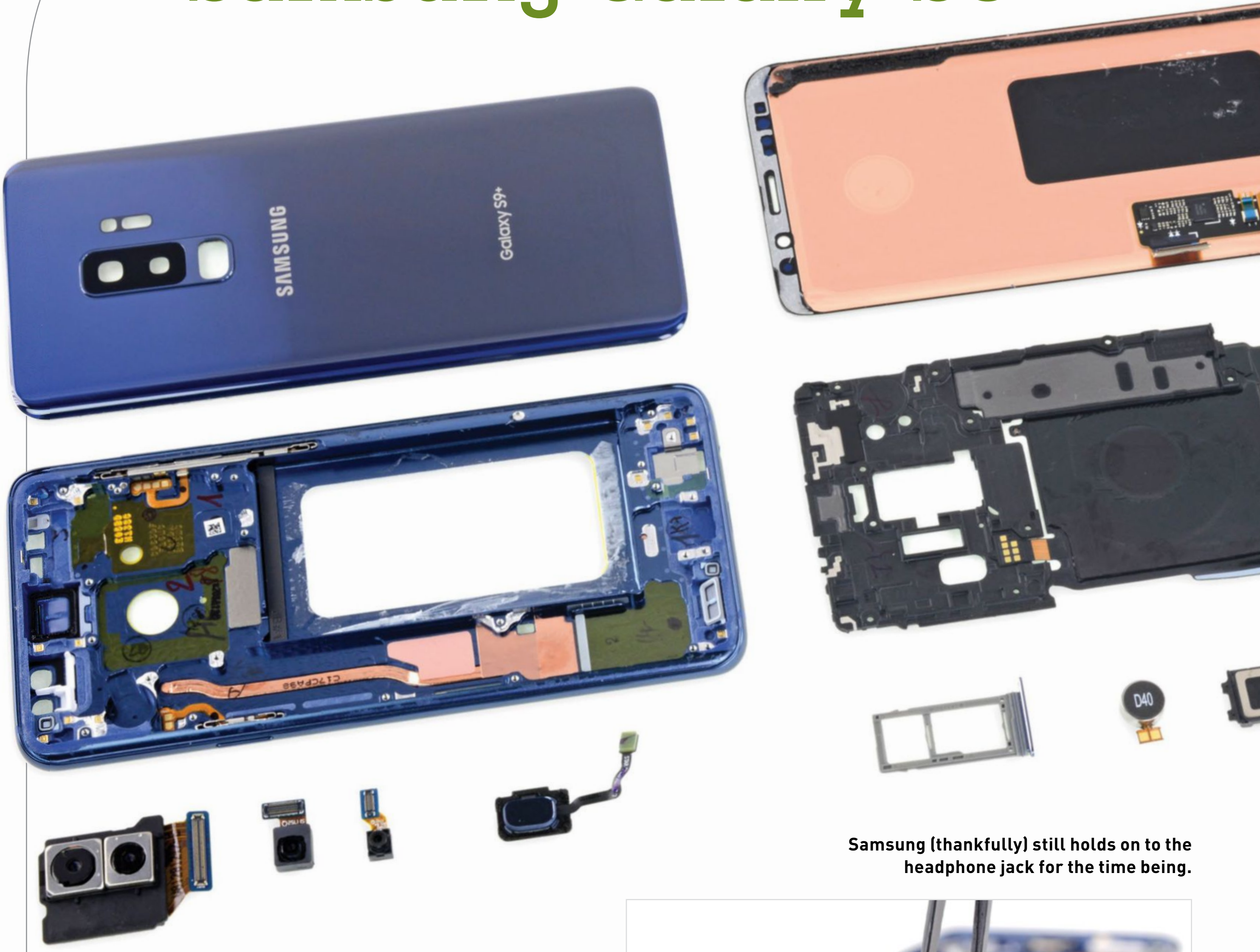
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

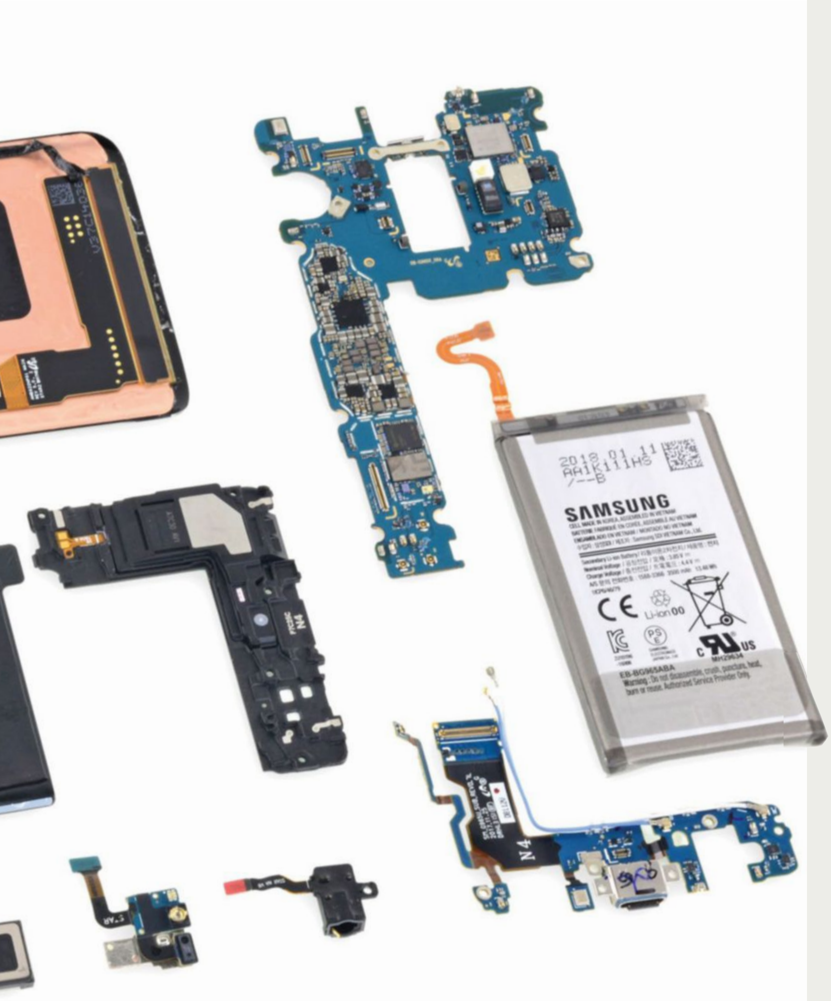
Samsung Galaxy S9+



Samsung (thankfully) still holds on to the headphone jack for the time being.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



Nothing quite beats getting rid of those unnecessary cables and charging your phone wirelessly.

BACKGROUND

While phone makers and operating system developers of dubious numeracy skip straight from eight to ten, Samsung stays strong and gives us the Samsung Galaxy S9+ (sans notch, even). Only a teardown will tell if this phone is a true contender, or just a weird AR Emoji machine.

MAJOR TECH SPECS

- Notchless 6.2-inch AMOLED display with resolution of 2960x1440 (570 ppi)
- Qualcomm Snapdragon 845 or Samsung's Exynos 9810, depending on location
- 12MP OIS dual-aperture main camera—f/1.5 and f/2.4 modes—plus a 12MP 2x optical zoom secondary camera, and an 8MP selfie cam
- Headphone jack and microSD slot
- IP68 water/dust-proofing rating
- Android 8.0 Oreo

KEY FINDINGS

- While it's no S4, the S9 is a welcome respite from our more recent destructive teardowns. The standard application of heat and opening pick helps us along, but it's definitely no picnic! Thanks to prior experience—no thanks to Samsung—we are able to safely dispatch the sensor assembly cable with no casualties.
- We head straight to the rear camera to get a look at the fancy new dual-aperture camera in action. The camera auto-adjusts the aperture to adjust for low light (at f/1.5, it's got the widest aperture of any phone), while maintaining a more standard (and sharper) f/2.4 for normal photos.
- What do you need to remove a glued-down battery from a Galaxy phone? Option one: lots of heat, a pry tool, a fire extinguisher, a bucket of sand, and nerves of vibranium. Option two: a syringe loaded with a little iFixit Adhesive Remover. We opt for the latter, and splash a bit of the blue stuff into the little tub that cradles the battery. A few minutes later, we have our prize.
- It's a hotbed of teardown activity as we attempt to unseat the display—but this glue is trying our patience, and we abandon our pile of iOpeners in favor of a heat gun once again. As before, the heat and opening pick can do the job, but it's a marathon slog to get here if you're replacing a broken screen. The Samsung-made display cable, like the cameras, is labeled "Star," and combines both display and digitizer in one sealed unit.
- Repairability Score: 4 out of 10 (10 is easiest to repair). Many components are modular and can be replaced independently. The battery replacement is technically possible, but accessing it is an unnecessary challenge. Glued-down glass both front and back means greater risk of breakage, and makes repairs difficult to start. Screen repairs require a lot of disassembly while battling tough adhesive.

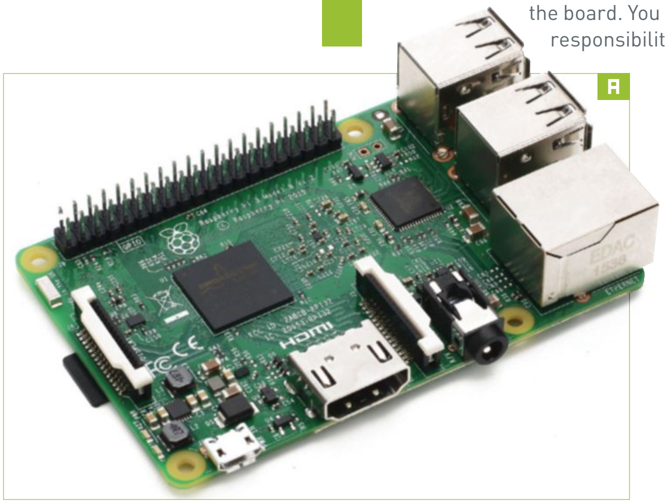
Build a Raspberry Pi Wireless Access Point

YOU'LL NEED THIS

A RASPBERRY PI 3 OR ZERO W
The third iteration's built-in Wi-Fi is what makes this project work.

WHY SHOULD YOUR WIRELESS ROUTER HAVE ALL THE FUN? Gaining access to your network—and through it, the Internet—is something you can do via a properly configured Raspberry Pi. This means you can easily extend the functional wireless range of your network with a little Ethernet cabling, build an access point especially for guests, or just add a handy new SSID to your home. And because your Pi access point will be built on top of Linux, using tried-and-tested tools from the more hardcore end of the software spectrum, you'll get all the control you could ever want over who accesses your network and precisely how it operates.

Note that we require a Raspberry Pi 3 or Zero W for this project [**Image A**], and are basing it around the slightly larger third edition. This is entirely down to the Pi's slightly lacking USB bus; adding a wireless module to an earlier edition severely affects the potential network bandwidth, because the USB and Ethernet ports share the same data rail, but later models build Wi-Fi on to the board. You could still employ the services of a Pi 2B or similar, but we accept no responsibility for any disappointing results. –**ALEX COX**


A

1 START FRESH

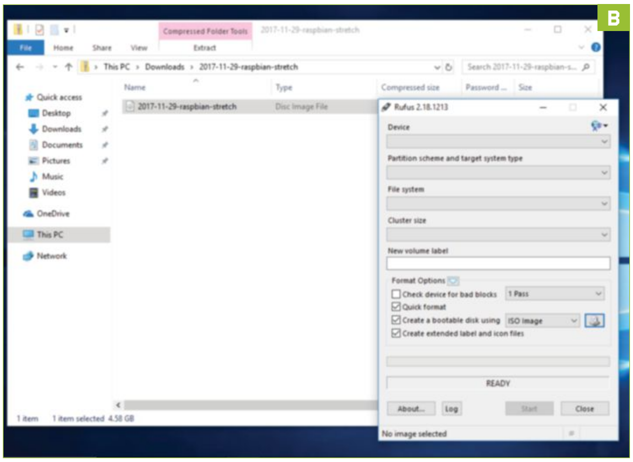
It's a common refrain when starting a Raspberry Pi project, but there are so many tiny variables involved in every Linux installation that we heartily recommend starting from scratch to make sure you're on precisely the same page. So, whip out your microSD card (or grab a new one), and insert it into your PC's card reader. Download a clean copy of Raspbian Stretch from www.raspberrypi.org/downloads/raspbian—you don't necessarily need the desktop version, as everything we're going to do is command-line-based, but we're grabbing the full version just in case—then unzip the file, and put the ISO somewhere you can find it. Next, find your SD writer of choice—we lean toward Rufus [**Image B**] (http://rufus.akeo.ie)—and write the file to your card. You'll lose any data that was on there before. Plug your Pi into an Ethernet connection, slip the card into your Pi, power it up, and get yourself booted up.

2 UPDATE AND DOWNLOAD

A freshly installed Raspbian system [**Image C**] isn't an up-to-date one. Either launch a terminal window from within the Raspbian PIXEL desktop, or drop out of the desktop to a tty console with Ctrl-Alt-F1. If you're using the lite version, you'll already be at the tty console. Next, for a little added security at this early stage, change your password by typing `passwd`. The default password on the account "pi" is "raspberry" so type that when prompted (it won't be displayed on screen), then enter your new choice. Now type `sudo apt-get update` (giving your new password if prompted) to refresh Raspbian's list of current packages, and `sudo apt-get upgrade` to download the latest version of every package on your system that isn't currently up to speed. This will take a while, because everything is compiled on the Pi's somewhat slow hardware at install time. There are a few packages we'll need that aren't installed by default, so pull them down with `sudo apt-get install dnsmasq hostapd`, then ensure neither dnsmasq (which handles DNS, DHCP, and router advertisement) or hostapd (responsible for wireless management and authentication) are running by typing `sudo systemctl stop dnsmasq` and then `sudo systemctl stop hostapd`. They're not configured yet, so it's best to fire them up later, once we've done the dirty work.

3 STABILIZE WI-FI

Check a couple of things before we move on, because your results may differ. Type `ifconfig -a -s` into your terminal, and note down your network device names. By default, these should be `wlan0` and `eth0`, but if they're not, you'll need to replace them in the following


B

Rufus 2.18.1213

Format Options
☐ Check device for bad blocks 1 Pass
☑ Quick format
☑ Create a bootable disk using ISO Image
☑ Create extended label and icon files

READY

No image selected

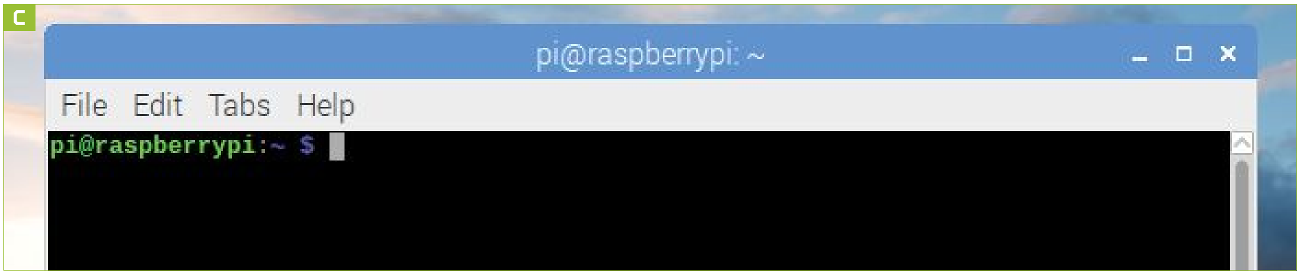
Compressed Folder Tools
2017-11-29-raspbian-stretch
File
Home
Share
View
Extract
This PC › Downloads › 2017-11-29-raspbian-stretch
Search 2017-11-29-raspbian-s...
Quick access
Desktop
Downloads
Documents
Pictures
Music
Videos
OneDrive
This PC
Network
Name
Type
Compressed size
Password ...
Size
2017-11-29-raspbian-stretch
Disc Image File
1 item
1 item selected 4.58 GB
Device
Partition scheme and target system type
File system
Cluster size
New volume label
About...
Log
Start
Close

VIABLE ALTERNATIVES

LINKSYS
WRT3200ACM

A Raspberry Pi 3 makes a reasonable access point, but it's not great—and it's unlikely to ever be, because the Pi is not speciality hardware. If you want an AP that you can tinker with and configure to within an inch of its life, routing hardware that supports a flavor of firmware-replacement WRT—be it OpenWRT or DD-WRT—is perfect. There's a long list of compatible hardware at http://wiki.openwrt.org/toh/start, including, if you look carefully, the Raspberry Pi. Again, don't expect blistering performance, but if you want to put together a specialized AP without spending hours fighting with tetchy config files that could break your whole setup in an infuriating instant (not that we're speaking from experience at all), the mature OpenWRT is worth poking at. Just make sure you download the correct version for your hardware: for the Pi 3, that's bcm2710.

C



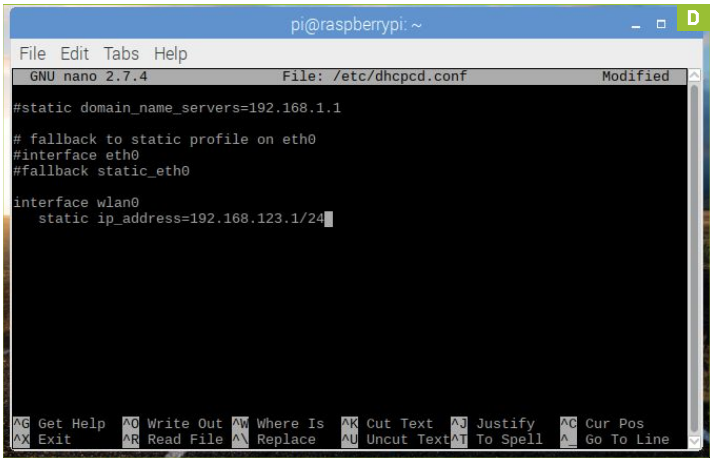
```
pi@raspberrypi:~ $
```

steps to match your own configuration. Run `sudo nano /etc/dhcpcd.conf` to open up the configuration file for the Pi's DHCP client, and head to the bottom of the file. Add the line `interface wlan0`, then below it add `static ip_address=192.168.123.1/24` to fix your Wi-Fi address in place [**Image D**]. We're using a different subnet (represented by the third digit, in this case 123, though you can set this to any valid value), but bridging—and using your router's existing DHCP and DNS features—is entirely possible if you install bridge-utils and use `man bridge-utils` to check out its manual. Quit nano with Ctrl-X, answer yes to saving the file, then run `sudo service dhcpcd restart` to put your new configuration in action.

4 SET UP DNSMASQ

We need to tell dnsmasq a few things about the access point we're trying to set up, but our limited network doesn't need half of the information that's found in its default configuration file. Rename the one that's there with `sudo mv /etc/dnsmasq.conf /etc/dsnmasq.conf.old`, then use `sudo nano /etc/dnsmasq.conf` to start editing a blank replacement. We'll only need three lines. Firstly, `interface=wlan0` to tell it which device to use. On the next line, add our definition of what dnsmasq is expected to provide: `dhcp-range=192.168.123.2,192.168.123.40,255.255.255.0,24h`. In order, this tells dnsmasq the start and end of the IP address range to allocate (you can tweak this), the subnet mask (leave this alone), and the lease time, in hours, to give to connected devices. Quit nano and save, and that's really all you need to do to get dnsmasq set up. While there's a raft of potential options listed in dnsmasq's manpage, it's not worth exploring them until you're confident everything works as it should. Break it later.

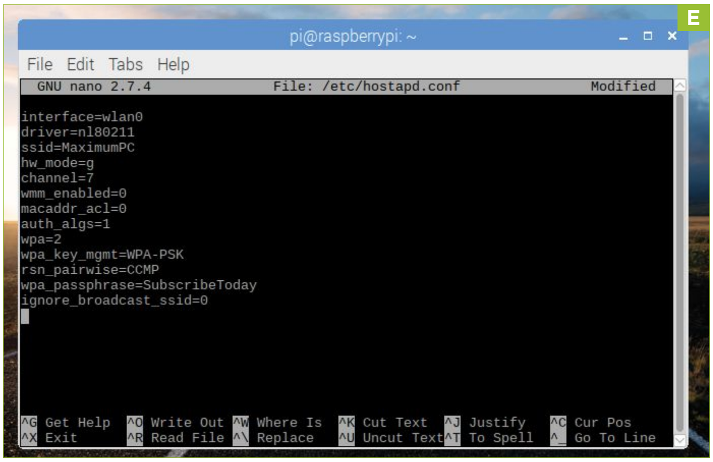
D



```
  GNU nano 2.7.4              File: /etc/dhcpcd.conf                    Modified

#static domain_name_servers=192.168.1.1

# fallback to static profile on eth0
#interface eth0
#fallback static_eth0

interface wlan0
   static ip_address=192.168.123.1/24

^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Uncut Text^T To Spell  ^_ Go To Line
```

5 SET UP HOSTAPD

With network routing cemented and local IP addresses ready to be dished out, it's time to deal with the more difficult part: wireless authentication. Hostapd doesn't come with a default configuration file, so start editing one with `sudo nano /etc/hostapd/hostapd.conf`. Note that the following variables, which you can edit later on to suit your particular network, need to be added line by line, with no spaces at the beginning of lines. We'll first define which device we're managing (`interface=wlan0`), which driver we want to use (`driver=nl80211` is Pi's default), and what we want our network to be called (`ssid=MaximumPC`). Next comes a little hardware definition. Add `hw_mode=g` to use the 2.4GHz wireless frequency, `channel=7` (or whatever the clearest network channel in your area is) to set the access point's wireless channel, `wmm_enabled=0` to disable wireless multimedia extensions for now, and `macaddr_`



```
  GNU nano 2.7.4              File: /etc/hostapd.conf                Modified

interface=wlan0
driver=nl80211
ssid=MaximumPC
hw_mode=g
channel=7
wmm_enabled=0
macaddr_acl=0
auth_algs=1
wpa=2
wpa_key_mgmt=WPA-PSK
rsn_pairwise=CCMP
wpa_passphrase=SubscribeToday
ignore_broadcast_ssid=0

^G Get Help  ^O Write Out ^W Where Is  ^K Cut Text  ^J Justify   ^C Cur Pos
^X Exit      ^R Read File ^\ Replace   ^U Uncut Text^T To Spell   ^_ Go To Line
```

`acl=0` to state that you don't want to use a MAC address access control list. Now let's set up a little security. Include `auth_algs=1` to specify that you're running in WPA mode, then `wpa=2` to use WPA2 specifically. Use `wpa_key_mgmt=WPA-PSK` and `rsn_pairwise=CCMP` to set a few crucial parameters, then `wpa_passphrase=SubscribeToday` (or any other string of characters between 8 and 64 characters) to define your WPA password. Once you've saved the configuration file [**Image E**], you need to tell hostapd where it is; type `sudo nano /etc/default/hostapd` at the shell, and replace the line beginning #DAEMON_CONF with `DAEMON_CONF="/etc/hostapd.conf"`.

6 START UP AND TRANSLATE

Those processes we stopped earlier can now be started again, using `sudo systemctl start hostapd` and `sudo systemctl start dnsmasq`. At this point, we could technically reboot and get the access point up and running, but we're still missing some crucial internal tweaks. Firstly, we need to enable IP forwarding by opening /etc/sysctl.conf and removing the hash symbol to uncomment the `net.ipv4.ip_forward=1` line, before saving the file. Next, we need to implement something called a masquerade. This is, broadly, a specialized network address translation algorithm that routes traffic between devices without disrupting the original packets in any way. Run `sudo iptables -t nat -A POSTROUTING -o eth0 -j MASQUERADE` to set it up, routing outbound traffic from eth0 onward on to your network. We now need to make sure that iptables runs the same way every time. You can use the iptables-save routine to drop its variables into a file with `sudo sh -c "iptables-save > /etc/iptables.ipv4.nat"`. Now let's set these rules to run every time the Pi boots up, by opening /etc/rc.local and adding `iptables-restore < /etc/iptables.ipv4.nat` just above the line that says `exit 0`.

TRAFFIC SHAPING

If you're planning to use your Pi as a guest network, or if you want to slow down your uploads to stop your download speeds taking a dive, Wondershaper is a great tool. It's tiny—really, it's just a 15kb script—but immensely powerful if you're looking to control the speed that traffic can move through your hardware. Begin by downloading it from the Pi's standard repositories using `sudo apt-get install wondershaper`, at which point you can go ahead and run it for the first time with `sudo wondershaper eth0 1024 1204`. This command restricts the download (first value) and upload (second value) of the Pi's Ethernet connection to an entirely unreasonable 1,024kb/s. You can check that it's working with `wondershaper eth0`, or by running a speed test at, for instance, www.speedtest.net [**Image G**]. This script is perhaps most useful if run at boot time, so (and, admittedly, this is a slight cludge) run `sudo nano /etc/rc.local` and add `/sbin/wondershaper`, followed by your preferred restrictions, then save the file, and reboot. If you ever want to stop Wondershaper's actions, just run `sudo wondershaper clear eth0` to clear its current parameters, or remove it from /etc/rc.local to stop it running automatically.

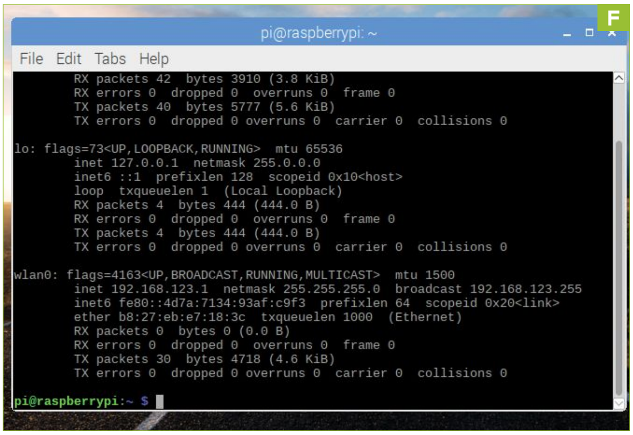
ANOTHER PI TUTORIAL NEXT MONTH

7 REBOOT AND TEST

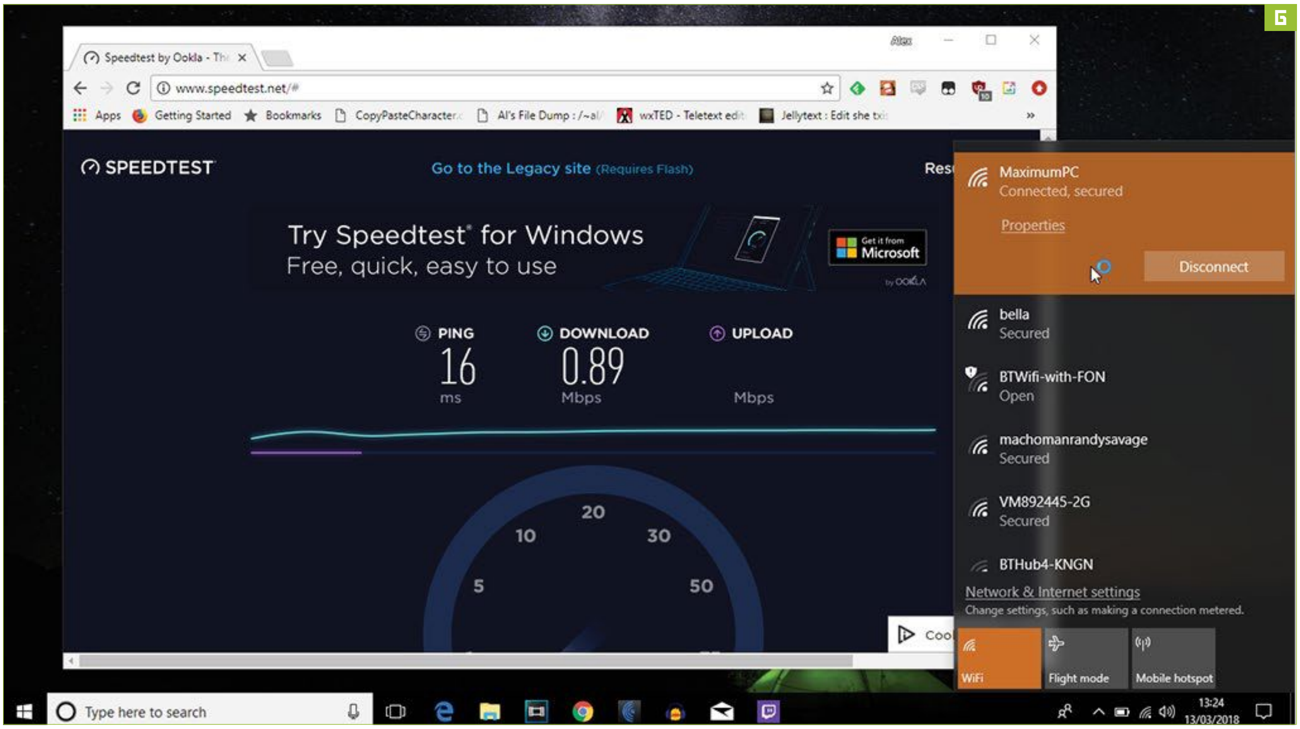
You can now safely reboot your Pi, either through PIXEL's graphical interface or by typing `sudo reboot` into the command line. You'll probably see an alert about some configuration files being overwritten—this is as a result of our earlier upgrade, and the configs you've set should be safe. All being well, everything will have fired successfully. Try a few things to make sure. Boot up a Windows machine (or your cell phone), and search for local networks; you should see your new SSID showing up. Connect to it, with the password you set earlier, and you should be able to access the Internet through it. Back on the Pi, run `ifconfig` in a terminal window; you should see the wireless interface [**Image F**] has been given an IP address. If you have any problems—and yes, this is small consolation given that you'll need to interpret Linux error messages—you can try a few things. Try manually starting hostapd and dnsmasq, and look out for any alerts. If they both seem to work and yet your network does not, run `sudo hostapd -dd /etc/hostapd.conf > /tmp/hostapd.log`, hit Ctrl-C to kill the process after 10 seconds or so, then run `nano /tmp/hostapd.log` to see hostapd's detailed diagnostic output.

8 TWEAK IT

So, you've got your own wireless access point. What can you do with it now? Carefully editing the hostapd.conf file gives you a lot of options to make it your own. Add the line `ignore_broadcast_ssid=1`, for example, to hide the Pi's SSID and keep your network private, or save some processing overheads and remove the WPA security altogether, as long as you're masochistic enough to allow an unsecured access point to run on your network. Your guests will thank you, but your ISP won't. While we wouldn't leave it open, the Pi is the perfect host for a guest

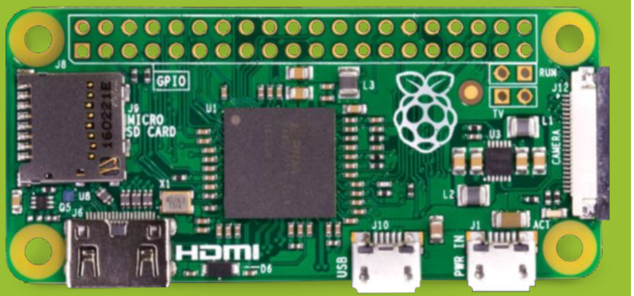


```
        RX packets 42  bytes 3910 (3.8 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 40  bytes 5777 (5.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1  (Local Loopback)
        RX packets 4  bytes 444 (444.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 4  bytes 444 (444.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.123.1  netmask 255.255.255.0  broadcast 192.168.123.255
        inet6 fe80::4d7a:7134:93af:c9f3  prefixlen 64  scopeid 0x20<link>
        ether b8:27:eb:e7:18:3c  txqueuelen 1000  (Ethernet)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 30  bytes 4718 (4.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

pi@raspberrypi:~ $ 
```


Speedtest by Ookla
www.speedtest.net/#
Apps
Getting Started
Bookmarks
CopyPasteCharacter
Al's File Dump
wxTED - Teletext edit
Jellytext : Edit
SPEEDTEST
Go to the Legacy site (Requires Flash)
Try Speedtest® for Windows
Free, quick, easy to use
Get it from Microsoft
PING
16
ms
DOWNLOAD
0.89
Mbps
UPLOAD
Mbps
MaximumPC
Connected, secured
Properties
Disconnect
bella
Secured
BTWifi-with-FON
Open
machomanrandysavage
Secured
VM892445-2G
Secured
BTHub4-KNGN
Network & Internet settings
Change settings, such as making a connection metered.
WiFi
Flight mode
Mobile hotspot
Type here to search
13:24
13/03/2018

network. You can hand out a password without giving up your main details, and it's even possible to restrict network throughput to stop your guests from bruising your main connection—see "Traffic shaping" for a little more on this. You're also now safe to run your Pi completely headless, because it will retain the same IP address. Before you unplug, though, make sure SSH is switched on by running `sudo raspi-config` and heading to "Interfacing Options > SSH." When it's running, reboot your Pi, unplug it from the keyboard, mouse, and monitor, then use PuTTY (www.putty.org) to connect to and administer it from your Windows machine. You won't get a pretty interface, but we suspect you'll be able to cope without.

BUILDING BRIDGES



Our main tutorial leads you to building, essentially, a self-contained network. One with its own subnet, its own range of IP addresses, and its own DHCP management. Devices you connect to it gain access to the Internet, and you get pinpoint control, but its isolated structure may not be entirely ideal. Building a network bridge instead leaves a lot of that hard work up to your router, and makes your access point far more of an extension of your existing network than a mini network unto itself.

We still need hostapd to deal with the wireless authentication side of things, as well as Debian's bridge-utils package, installed via `sudo apt-get install hostapd bridge-utils`. Stop hostapd (`sudo systemctl stop hostapd`), then open up the dhcpcd configuration file for editing with `sudo nano /etc/dhcpcd.conf`. Because our bridge will be the logical network device, rather than either the Pi's Ethernet or Wi-Fi modules, we now need to stop them from receiving their own IP addresses by adding `denyinterfaces wlan0` and `denyinterfaces eth0` to the end of the file, on separate lines. Save the file and exit back to the shell.

Now we'll add our bridge—again, this is virtual network hardware, the Pi acting as a go-between for our network ports—by typing `sudo brctl addbr br0`, and then connect it to our Ethernet port with `sudo brctl addif br0 eth0`. With the two hooked up, we need to define the bridge interface a little more clearly by running `sudo nano /etc/network/interfaces`. Scroll down to the bottom of the file (there's a good chance it won't be too long), and add the following definitions line by line. First, `auto br0` to bring the interface up at boot time, then `iface br0 inet manual` to tell the bridge that we want the router's DHCP service to deal with assigning it an IP address. Finally, `bridge_ports eth0 wlan0` tells the bridge precisely what you want it to do—that is, sit between the Ethernet and Wi-Fi devices, and bridge all network ports between them.

The final step, once the interfaces file is saved, is to open up /etc/hostapd/hostapd.conf and write your configuration file. Follow the steps under "Set up hostapd" in the main tutorial, but instead of including the line `driver=nl80211`, drop in `bridge=br0`, telling your access point to connect you to the bridge adapter. Save, reboot, and use `ifconfig` to test whether your bridge is now active; it should be the only device assigned an IP address.

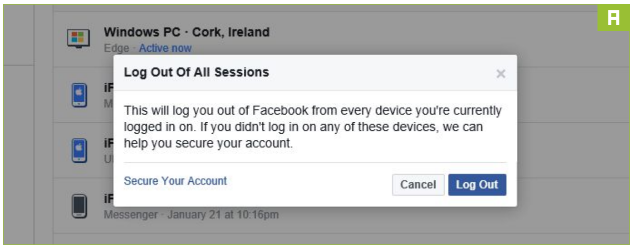
Lock Down Facebook to Protect Privacy

THERE ARE CURRENTLY OVER 2 BILLION ACTIVE FACEBOOK USERS. The platform is a great way to stay in touch with friends and family, especially considering it's free to use. The fact that virtually everyone has an account, however, means it can be difficult to make sure that the status updates, photos, and messages you share stay only within a limited audience of friends. While Facebook has some very powerful privacy features, these are not all enabled by default. For instance, when you create a new account, your public profile is automatically visible to search engines such as Google. This can include information such as your name, birthday, and home town.

In this guide, you'll discover how to lock down Facebook to give you back control of your data. You can do this firstly by keeping track of the devices where you're logged in, and enabling extra security for new sign-in attempts. You can also fine-tune which sections in your timeline are visible to people who aren't confirmed Facebook contacts, such as your friends list, timeline posts, and places you've checked in. You'll also explore some ways to block annoying ads and tracking cookies on the site itself. **–NATE DRAKE**

YOU'LL NEED THIS

WEB BROWSER
If installing the Adblock Plus or Ghostery extensions, your browser must meet the minimum requirements (see https://adblockplus.org/requirements and www.ghostery.com/products).



Windows PC · Cork, Ireland
Edge · Active now

Log Out Of All Sessions

This will log you out of Facebook from every device you're currently logged in on. If you didn't log in on any of these devices, we can help you secure your account.

Secure Your Account

Cancel | Log Out

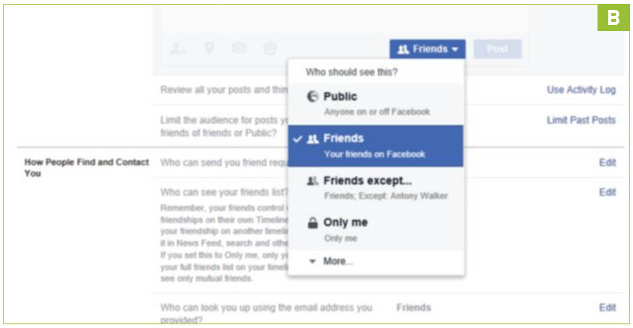
Messenger · January 21 at 10:16pm

1 DISABLE AUTOMATIC LOGINS

Facebook is designed to be easy to use, so that it remembers logins, and even allows you to access your account by clicking your profile picture. As convenient as this is, if someone were to get to your machine, they could access your account without permission. Click on the options arrow at the top-right of the Facebook screen, and choose "Settings → Security and Login." From here, you can click "Edit" beside "Log In with your Profile Picture" to turn this feature off [**Image A**]. While you're here, click "See More" under "Where you're logged in," and choose "Log Out of All Sessions." Click "Edit" beside "Change Password," and choose a new, strong one.

2 ENABLE TWO-FACTOR AUTHENTICATION

If you set up two-factor authentication (2FA), each time you log in to Facebook from a new device and/or browser, you need to enter a six-digit code as well as your password. This makes it much harder for hackers to access your account. You can enable this from the "Security and Login" screen you opened in the previous step. Scroll down to "Use two-factor authentication," and click "Edit." You need to choose an authentication method—for example, to receive a code via SMS. Click "Enable" once you've confirmed your choice.



Friends ▾ | Post

Who should see this?
- Public — Anyone on or off Facebook
- ✓ Friends — Your friends on Facebook
- Friends except... — Friends; Except: Antony Walker
- Only me — Only me
- More...

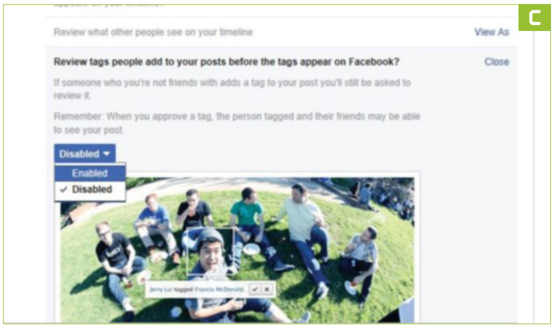
Review all your posts and thin — Use Activity Log

Limit the audience for posts y friends of friends or Public? — Limit Past Posts

How People Find and Contact You — Who can send you friend requ — Edit

Who can see your friends list? — Edit
Remember, your friends control friendships on their own Timeline your friendship on another timeli it in News Feed, search and othe If you set this to Only me, only y your full friends list on your timel see only mutual friends.

Who can look you up using the email address you provided? — Friends — Edit



Review what other people see on your timeline — View As

Review tags people add to your posts before the tags appear on Facebook? — Close

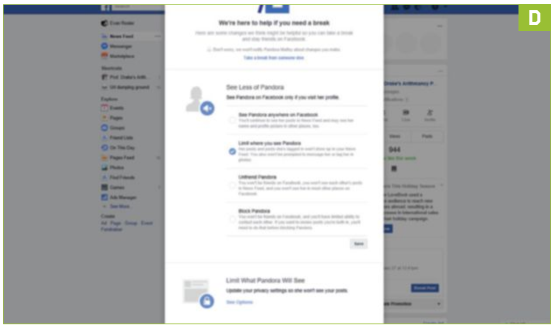
If someone who you're not friends with adds a tag to your post you'll still be asked to review it.

Remember: When you approve a tag, the person tagged and their friends may be able to see your post.

Disabled ▾
- Enabled
- ✓ Disabled

3 CHANGE PRIVACY SETTINGS

Facebook has a dedicated "Privacy" section, which you can find under "Settings." Click "Edit" next to "Who can see your future posts" to change to "Friends" only. Make sure to click "Limit Past Posts," too, to make sure only confirmed friends can see posts on your timeline. Next, click "Edit" next to "Who can see your friends list?" and change to "Only Me." Click "Edit" on the next two options to make sure that only your confirmed friends



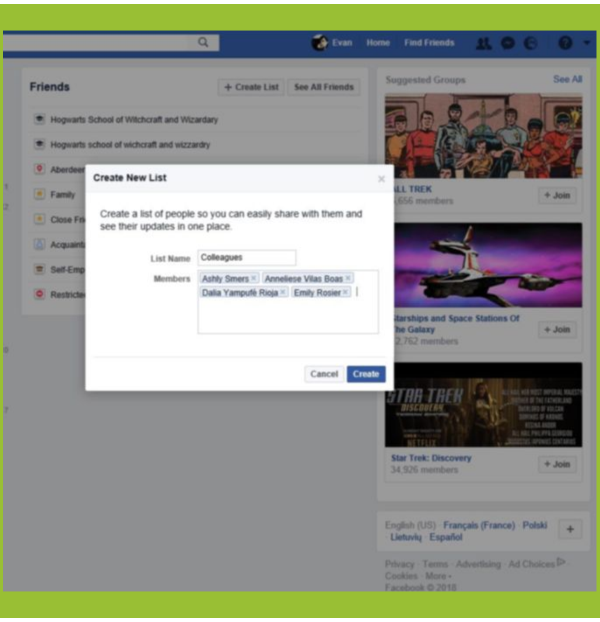
We're here to help if you need a break

See Less of Pandora
See Pandora on Facebook only if you visit her profile.
- ○ See Pandora anywhere on Facebook
- ● Limit where you see Pandora
- ○ Unfriend Pandora
- ○ Block Pandora

Limit What Pandora Will See
Update your privacy settings so she won't see your posts.
See Options

MANAGE YOUR LISTS

When you post an item to your timeline that isn't visible to the public, you can control who sees it by using lists. Click on "Friends List" on the left to get started, then on the "Create List" button. From here, you can create a new group—"Colleagues," for example—and add members to it. Click "Save" when you're done. In future, when creating posts, click the "Audience selector" button, then "More → See All." You can now select a "Custom" view for your post, such as to show to all friends except those in your "Colleagues" list. Click the "Friends" tab in your timeline and hover over "Friends" next to the name of a person to add a person to a list. Facebook has several pre-configured lists for you: "Acquaintances" is self-explanatory; use "Restricted" to make sure friends only see your public posts or those in which you've specifically tagged them. There's also a "Close Friends" list. If you add someone here, you'll receive a notification every time they post. Facebook also tries to generate "smart" lists for you automatically, for family members or people who share your job or home town.


Evan
Home
Find Friends
Friends
+ Create List
See All Friends
Hogwarts School of Witchcraft and Wizardary
Hogwarts school of wichcraft and wizzardry
Aberdeen
Family
Close Fri
Acquaint
Self-Emp
Restricte
Suggested Groups
See All
+ Join
Starships and Space Stations Of The Galaxy
2,762 members
Star Trek: Discovery
34,926 members
English (US) · Français (France) · Polski · Lietuvių · Español
Privacy · Terms · Advertising · Ad Choices · Cookies · More ·
Facebook © 2018

Create New List

Create a list of people so you can easily share with them and see their updates in one place.

List Name: Colleagues

Members: Ashly Smers, Anneliese Vilas Boas, Dalia Yampufé Rioja, Emily Rosier

Cancel
Create

can search for you using your registered email address and phone number [**Image B**]. Finally, click "Edit" next to "Do you want search engines outside Facebook to link to your profile?" and uncheck the box. Other Facebook users can still find you using the search bar.

4 TIMELINE AND TAGGING

Your "Timeline and Tagging" settings can also be found in "Settings" immediately below "Privacy." From here, you can control both who can post in your timeline and who can see them and any other posts you're tagged in [**Image C**]. Work through both the "Timeline" and "Tagging" sections by clicking "Edit" and changing the settings to "Friends" only. If you don't access Facebook often, click "Edit" next to "Review posts you're tagged in before the post appears on your timeline?" and set to "Enabled." You can do the same for tags people add to your posts, too, if you wish.

5 BREAKING AND BLOCKING

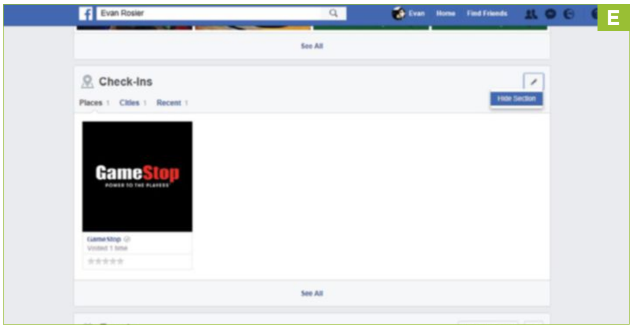
If someone is regularly posting content you don't enjoy, Facebook enables you to "take a break," unfriend them, or block them. Visit www.facebook.com/?take_a_break=1 to get started [**Image D**]. Enter the person's name to see the options available to you. Click "More options" under "See less of X" to explore further. If you want to remain friends with them, choose "Limit Posts" so that your friend's posts and any they're tagged in won't appear in your news feed. If you choose to "unfriend" a person, they can still see Public posts on your timeline, and contact you via Messenger. If you choose to "block" another user, they can neither view your timeline nor message you.

6 MANAGE ABOUT PAGE

Your public timeline contains a large amount of personal information by default. Click "About" on your timeline to manage this. Work through the sections on the left-hand side. Click "Edit" next to each item to ensure that these are visible only to confirmed "Friends." Scroll further down the page to view sections such as "Check In" and "Events." These are visible to the public by default [**Image E**]. Click the "Edit" button at the top-right and choose "Hide Section" to remove this from your timeline. This won't prevent you from posting check-ins and attending Facebook events in your own news feed.

7 BLOCK ADS & TRACKERS

Although Facebook does its best to make sure advertisements meet community standards, they can be very distracting, and if you accidentally click on them, they may take you to a site containing harmful code. You can prevent this by installing an ad-blocking browser extension, such as Adblock Plus (https://adblockplus.org). Facebook also uses "tracking cookies" to gather information about your browsing habits in order to show you targeted content. You can block most types of cookies by installing the Ghostery browser extension (www.ghostery.com). Both of these extensions are available for Microsoft Edge, Chrome, Opera, and Firefox. Click on the icon for each extension at any time to see which ads and/or cookies have been blocked [**Image F**]. ⏻


E
Evan Rosier
Evan
Home
Find Friends
See All
Check-Ins
Places
Cities
Recent
Hide Section
GameStop
See All

F
What's your magical name ?

Record a Remote Podcast Without Lag

YOU'LL NEED THIS

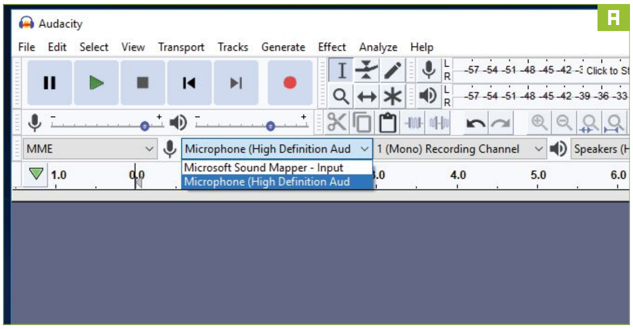
AUDACITY
The best free audio editor, from www.audacityteam.org.

ANY VOICE CHAT
Use Discord, Skype, or whatever is your favorite.

DECENT MICS
Solid source audio is crucial.

EVEN WITH ALL THE ADVANCES OF THE INTERNET, remote recording is a tremendously difficult task. There are so many hurdles to overcome: Lag makes conversation stilted and uncomfortable, traffic spikes lead to robotic-sounding voices, and the quality, particularly if you're using a low enough bitrate to overcome most of the lag, is often highly disappointing. Or even half-disappointing, because recording at one end of a two-way conversation means one participant is clear, while the other is much less so. While there are voice recorders that can act as a virtual participant in a conversation—which solves the disparity problem a little—the solution, as it is in so many cases, is to cheat. Instead of recording a live version of what happens online, you record what happens on either end, then piece it together later on.

This isn't, in itself, the path to perfect sounding podcasts. It can't overcome room echo, poor microphones, or shoddy mixing. Those are problems you'll need to solve yourself. But if you have a semi-decent audio setup on either end, and a small amount of time for editing once everything's recorded, the quality is a league above that of a straight online conversation. **–ALEX COX**


A
Audacity
File
Edit
Select
View
Transport
Tracks
Generate
Effect
Analyze
Help
MME
Microphone (High Definition Aud
Microsoft Sound Mapper - Input
Microphone (High Definition Aud
1 (Mono) Recording Channel
Speakers (H
Click to St
1.0
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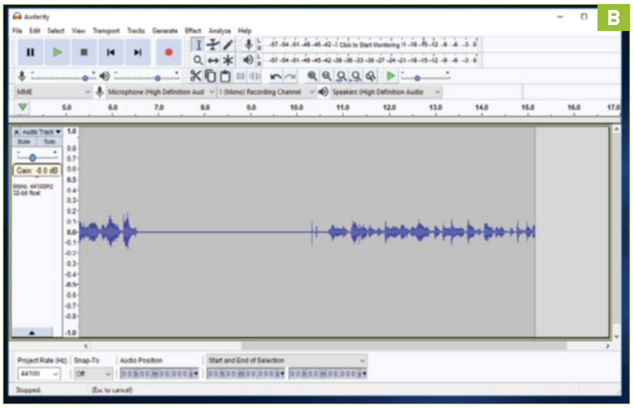
4.0
5.0
6.0


B
Audacity
MME
Microphone (High Definition Aud
1 (Mono) Recording Channel
Speakers (High Definition Audio
Audio Track
Gain: -8.0 dB
Project Rate (Hz)
Snap-To
Audio Position
Start and End of Selection
44100
Off
Stopped.

1 PREPARE YOUR STUDIOS

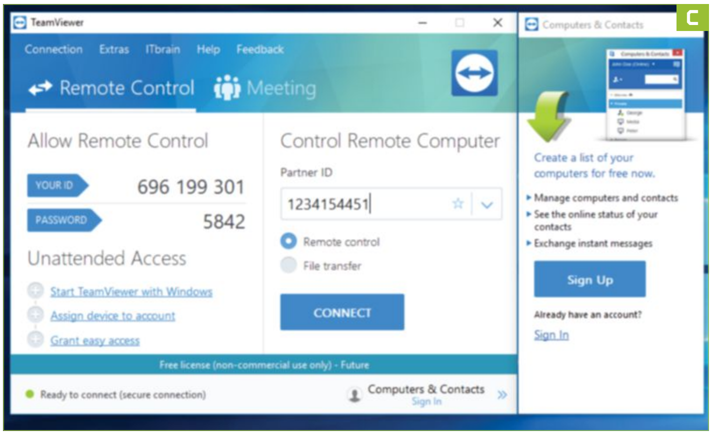
Before you touch any software, get the environment right. Think of either end of your conversation as an individual recording studio; no amount of post-processing is going to fix a poor-quality source. Each participant needs a decent mic—a high-end headset mic will probably suffice, but a powered condenser mic or a properly mounted passive mic, along the lines of a Shure SM-58, is better—and an area without too many echoes or reflections. Pinning up blankets and carefully positioning pillows can absorb the most heinous sounds, while, later, reducing the gain on your mics and keeping them close to each participant should keep everything focused on the voice, rather than the room. Headphones, preferably closed-back cans or low-leak earbuds, are an absolute must, because you want to keep each end of the conversation completely separate until you later combine them.

2 READY THE RECORDER

Although recording is a fairly mission-critical operation, we're going to recommend you use Audacity at either end, because it's free, and not nearly as crash-prone as it once was. Download version 2.2.2 from www.audacityteam.org, install it, then run it. Use the drop-down box at the bottom of the control bars at the top of the window to ensure that the correct microphone input is selected [**Image A**], set mono mode (because stereo really isn't required here), then do a quick test recording. Stay quiet for a while, then speak. Stop recording, then drag the bottom of the recorded waveform so that you can see it in detail. If your periods of silence show more than the vaguest glimmer of a ripple of sound, your mic is too hot; drag the uppermost slider on the left of the recording [**Image B**] to reduce its gain, then try another test recording until you're happy that it's only capturing the sounds you want in your podcast. Don't be tempted to add any effects, or blast your levels too high—you can enhance things later, but you won't be able to fix clipping or a poor-quality source.

3 GO REMOTE

Your other participant needs a setup as similar to yours as possible to guarantee audio consistency. Even if you don't have the same hardware, it's important to get similar levels; if your buddy is unable to do it themselves, hop on to their machine with some simple software, such as TeamViewer [**Image C**] from www.teamviewer.com, and tweak it for them. With both ends now set up to record the audio source, you can jump on your preferred voice chat service—Discord, Skype, Google Hangouts, a cell phone call, whatever. We recommend avoiding video chats if at all possible, just to keep system overheads low, and make sure your incoming audio isn't going to feed back to your mic. When you're ready to go, start up Audacity at either end, hit "Record," then set your mark—the point at which you'll line up the audio later on. Without a mark, it can be very difficult to ascertain exactly where the audio should


TeamViewer
Connection Extras ITbrain Help Feedback
Remote Control
Meeting
Allow Remote Control
Control Remote Computer
Unattended Access
Start TeamViewer with Windows
Assign device to account
Grant easy access
CONNECT
Free license (non-commercial use only) - Future
Ready to connect (secure connection)
Computers & Contacts
Sign In
Create a list of your computers for free now.
Manage computers and contacts
See the online status of your contacts
Exchange instant messages
Sign Up
Already have an account?
Sign In

YOUR ID 696 199 301

PASSWORD 5842

Partner ID 1234154451

● Remote control

○ File transfer

C

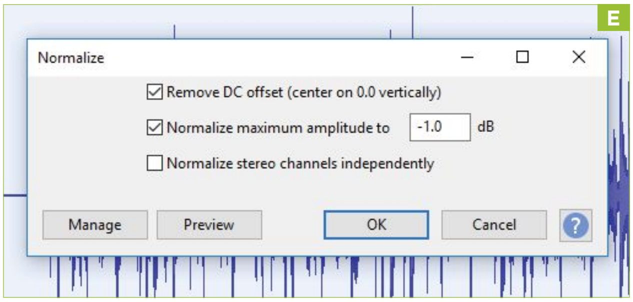
be slotted; a simple "Three, two, one, mark," counted together, should be enough, or spiking the mics with a loud clap [**Image D**] can help to visually line them up later. We'll leave the rest of the talking up to you.

4 COMPILE THE FILES

Once you've finished up your podcast, each end should stop recording, and export the file. Note that exporting is important—you don't want to deal with an Audacity project; you just want the raw audio. An OGG file at maximum quality is far smaller than the equivalent WAV, and the differences are not noticeable—given that the next step is for your remote participant to send over their file, this can be important. A service such as WeTransfer (www.wetransfer.com) should be perfect for this. Unless you've been talking for days, its 2GB limit should be more than large enough to cover the file being shared.

5 COMBINE

Open each file in Audacity individually, and do a little processing. First, select a few seconds of quiet, and run "Effects → Noise Reduction." Click "Get Noise Profile," then "OK" to chop out any rogue frequencies. The default settings should be fine, but use your ears to make a decision. Once done, select onward from your clap mark, and bring each track up to a similar level with "Effects → Normalize" [**Image E**]. Then export each track. Now, to line your audio tracks up, you need to use the Audacity Time Shift tool. First, start a new project, and open both audio tracks with "File → Import." They'll line up, one above the other. Work out which track is ahead, and which is behind the other. Double-click the track that's ahead, and click the button with combined left and right arrows on the top bar. Then drag the track [**Image F**] until your marks match—this needs a bit of listening. Once it's all in sync, listen through, because recording blips may pull certain sections back out of sync later on, then you can trim the edges, export the result, and share it. ⏻

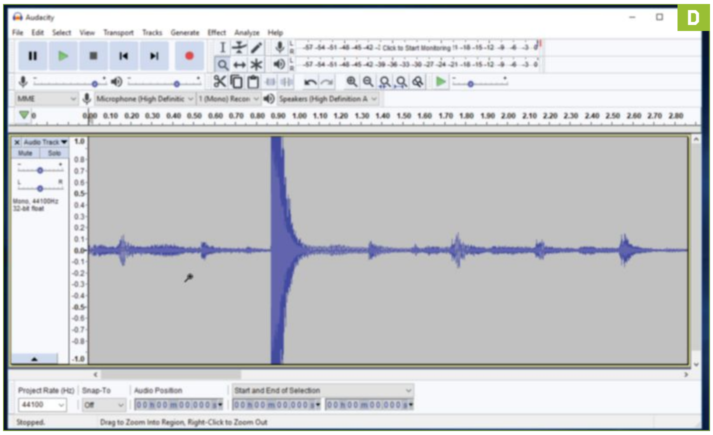

Normalize
Manage
Preview
OK
Cancel
?

☑ Remove DC offset (center on 0.0 vertically)

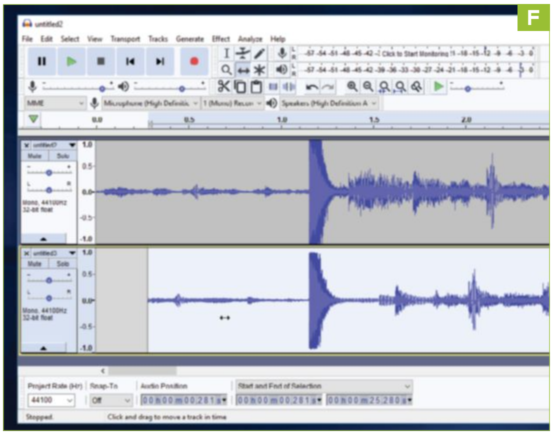
☑ Normalize maximum amplitude to -1.0 dB

☐ Normalize stereo channels independently

E


Audacity
File Edit Select View Transport Tracks Generate Effect Analyze Help
Audio Track
Mute Solo
Mono, 44100Hz 32-bit float
Project Rate (Hz) Snap-To Audio Position Start and End of Selection
44100
Stopped.
Drag to Zoom Into Region, Right-Click to Zoom Out

D


untitled2
File Edit Select View Transport Tracks Generate Effect Analyze Help
Mute Solo
Mono, 44100Hz 32-bit float
Project Rate (Hz) Snap-To Audio Position Start and End of Selection
44100
Stopped.
Click and drag to move a track in time

F

SKIP THE DRAMA

It's easy to be critical of Skype, Discord, and the like in this context, because they're simply not made for podcasts. There is at least one free alternative out there that does a passable job of live recording, because its technology has been built with low-latency, high-bandwidth conversations in mind, almost like the dedicated ISDN connections that are, in some parts of the world, still used today to record live radio interviews. The little-known Source-Connect Now is a perfect tool to try if you're desperate to avoid the editing, and get your podcasts online without too much hassle. The free version, which you can get via http://now.source-elements.com, connects two participants at a perfectly reasonable 128kb/s, and has built-in support for WAV recording—you'll still need to do a little conversion and trimming before you can share your work, but this dodges the file-sharing aspect, and reduces the pressure on your co-conspirator to get everything right. Ten-person conferencing and quality up to 512kb/s is available in the full version, although it comes with business-level pricing.

Tilt-Shift Like a Photographic Pro

YOU'LL NEED THIS

ADOBE PHOTOSHOP
Subscribe to various packages at www.adobe.com.

TILT-SHIFT PHOTOGRAPHY HAS A LONG HISTORY, and is a complex subject, requiring a special lens that can move relative to the plane of the film or sensor that it's casting light on. Over time, the term has come to be used for the simulation of razor-thin depth of field on digital compositions, particularly when it comes to creating a miniature effect—the idea that you're looking down on a tiny model of something, rather than at the object itself.

That's what we're looking at here. The diorama illusion makes something look like a scale model of itself, and can fool your brain so completely that it takes a moment to process what you're looking at. It works because depth of field decreases as magnification increases, so the limited part of the image that's in focus tricks the eye into thinking it's closer than it is, and therefore what you're looking at must be very small. But to get there, you need some Photoshop trickery.... **–IAN EVENDEN**

1 CHOOSE A PHOTOGRAPH

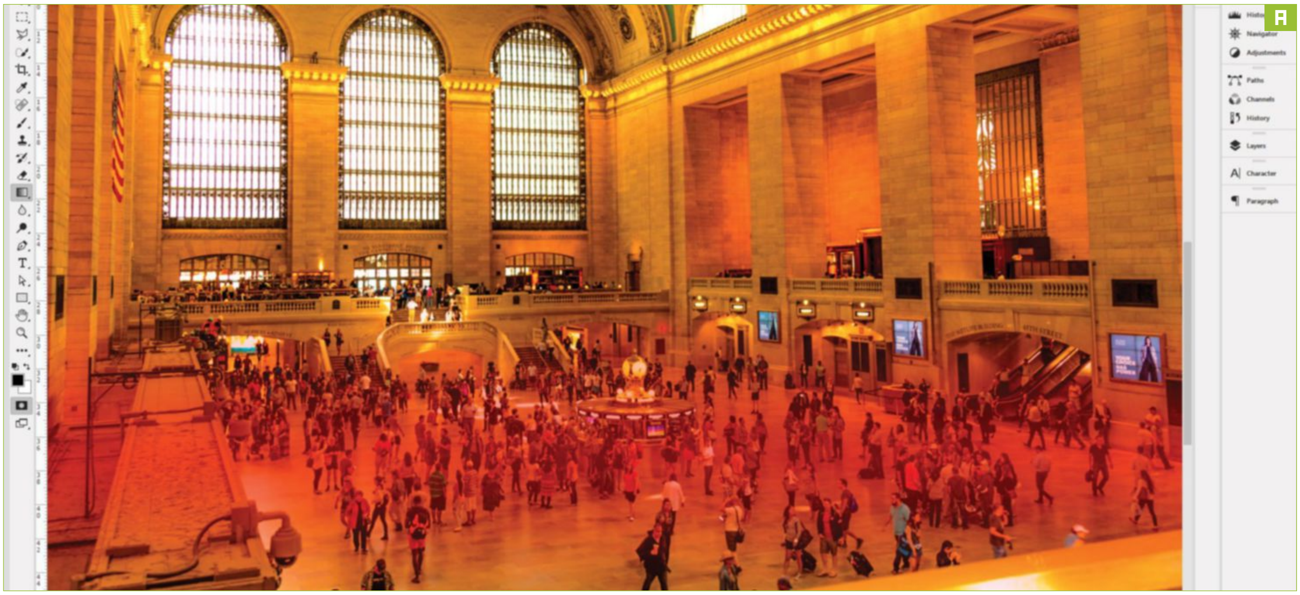
Selection of image is key here. You want something with a strong central subject that can be kept sharp, while the rest of the image dissolves in various levels of blur. Cityscapes shot from above work very well, as do soccer games, or railroads—especially if you can see trains passing one another. If you're lucky enough to get a bird's eye view of an airbase or airshow, a row of jet fighters lined up with military precision makes for a fine subject, even better if you can catch an aerobatics team taking off in formation. Whatever you choose, look out for strong shapes and central features, plus a receding background—something you can imagine being made into a model, no matter how intricate it would be.

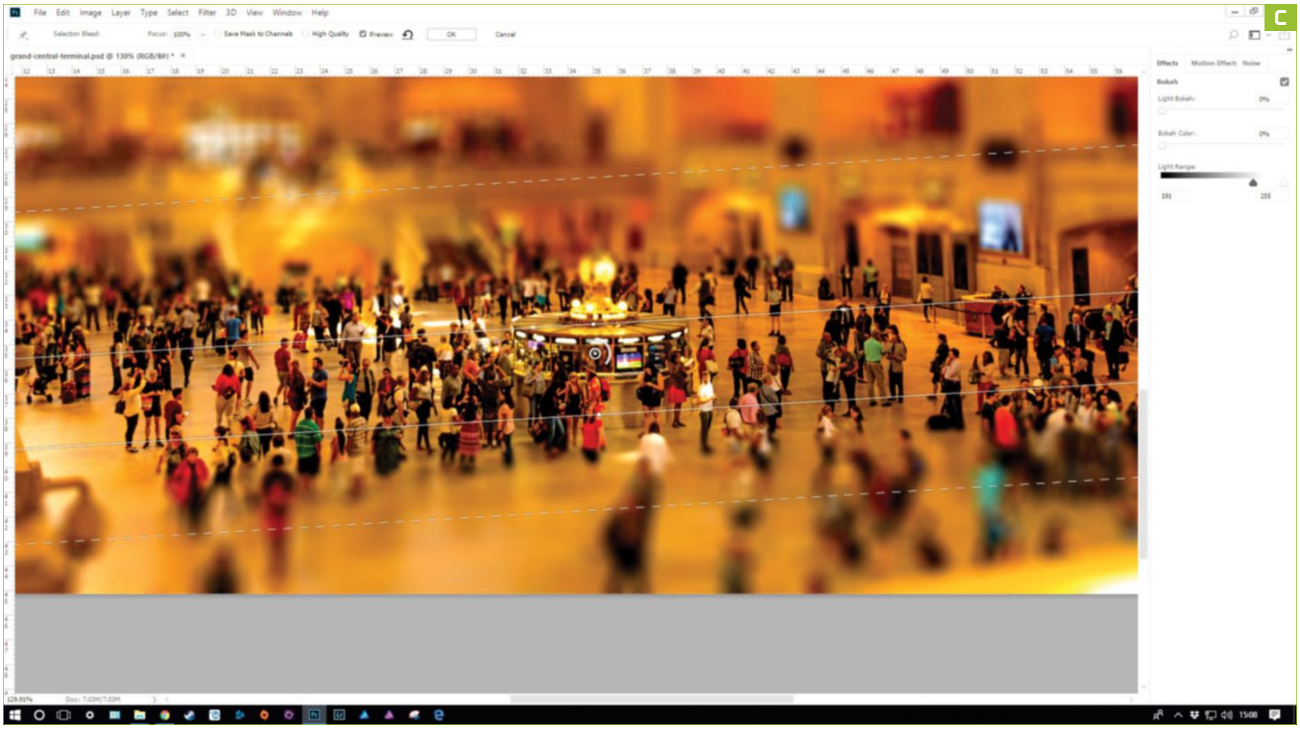
2 PREP YOUR IMAGE

It can be a good idea to play around with your photo in Lightroom or Camera Raw, before you get on to the tilting and shifting. You want your image to have crisp edges, so a little bump of the "Clarity" slider might be a good idea. Not too much, though, as this can create ghosting—edges that aren't really there along the lines of existing ones. Push the saturation a little, too—models are rarely painted naturalistically, and brighter colors will enhance the illusion that you're looking at something small. You can apply Camera Raw from the "Filter" menu in Photoshop CC, and to any image, not just Raw files.

3 ADD A GRADIENT

Now's a good time to save or create a History snapshot, as you may want to return to this point over and over again. Put Photoshop into Quick Mask mode using the button (a rectangle with a circle inside) at the bottom of the toolbar, near the colors. This means that whatever you paint now will become a selection when you exit the mode. Make sure the default colors are set, then select the Gradient tool from the toolbar—it looks like a rectangle fading from black to white, and nests with the Paint Bucket—and select the fourth option along in the "Options" bar at the top: a reflected gradient. Now draw a straight line up the picture (hold Shift) that covers and slightly exceeds the area of the image you want to remain in focus. Try this as many times as it takes to get it right. If you want to place the gradient at an angle, you can, but keeping perpendicular to the edge of the image is probably easier to begin with.


A


C
File Edit Image Layer Type Select Filter 3D View Window Help
OK
Cancel
Effects Motion Effects Noise

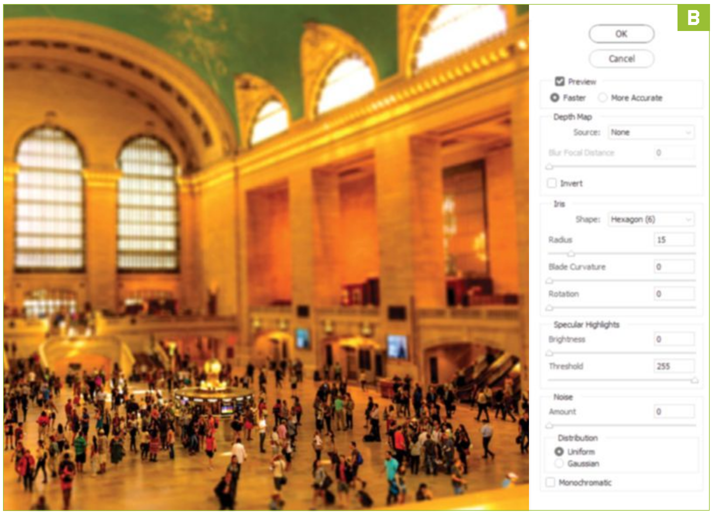
Bokah ☑
Light Bokah: 0%
Bokah Color: 0%
Light Range: 191 255

4 FAKE FRILLS

You should find the intended sharp part of your image fills with red, and that it gradually fades out as it moves away, marking the transition from sharp focus to blur [**Image A**]. Exit Quick Mask mode using the same button you used to enter it, and you should have the familiar marching ants of a selection. Go to the "Filter" menu, and choose "Lens Blur" from the "Blur" options. A new window opens [**Image B**], giving you a few options for faking the type of lens used to shoot the diorama. Mess with them if you want, but we found the default settings produced a pleasing result. Hit "OK," and admire your work.

5 ALTERNATIVELY...

This wouldn't be Photoshop if there wasn't more than one way of doing things, and Adobe has seen fit to introduce a Tilt Shift filter of its own. Using this, found on the "Filter" menu under "Blur Gallery," you can set the sharp point of your image without having to draw a gradient first. To our eye, however, it creates a slightly less convincing effect than the first method, probably thanks to the use of the Lens Blur filter. It's friendly enough to use, and offers the ability to constantly preview the effect [**Image C**]. At the center of the image is a pin, which marks the center of your sharp area, so move it to the correct place. The lines surrounding it mark the beginning and end of the blur transition, and can each be moved independently to fade the sharpness in and out as smoothly or suddenly as you want. You can have more than one pin, but there seems little need to for a diorama, and once you've created one, they can be hard to get rid of without starting over. You get plenty of options with this filter, with a useful slider for altering how highlights are treated in the bokeh, adding an ecclesiastical quality to any photo containing big windows. When you're happy, hit "OK" at the top of the interface, and save your new creation. ⏻



☑ Preview
● Faster ○ More Accurate
Depth Map
Source: None
Blur Focal Distance 0
☐ Invert
Iris
Shape: Hexagon (6)
Radius 15
Blade Curvature 0
Rotation 0
Specular Highlights
Brightness 0
Threshold 255
Noise
Amount 0
Distribution
● Uniform
○ Gaussian
☐ Monochromatic

MOVING PICTURES

If you've got a lot of time on your hands, a copy of Premiere Pro, a camera with an interval timer, and a tall building overlooking a busy intersection nearby, you can make a tilt-shift time-lapse movie of the cars passing by. Speeding up the clip slightly adds to the sensation that you're looking at models, rather than reality, and Premiere supports similar masks and blur effects as Photoshop. You can even use keyframing to animate the blur. Real pros using Adobe After Effects can use Compound Blur and depth maps to do the same thing with more control, and it's interesting to note how different blur styles alter the final result. We found Lens Blur to be the best in Photoshop, but experiment for yourself with the different blurs available.

BUILD IT

ALAN DEXTER, EXECUTIVE EDITOR

AMD Budget Masterclass

Ryzen APUs bring bucketloads of bounty to the budget builder's back pocket

LENGTH OF TIME: **1–2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

THE IDEA BEHIND our budget builds is simple enough—construct the most affordable machine possible for the smallest pile of cash. We're not utter masochists, though, so while it is possible to build a machine even cheaper than we have here, there are some quality-of-life choices that we see as a bare minimum. We won't, for instance, touch non-brand hardware, because we've been down that road before, and in our experience, such corner-cutting never ends well—especially when it comes to cases and power supplies. But it does mean that even before we start, there are potentially further savings to be made. But we're getting ahead of ourselves here; let's get back to the concept....

What makes this budget build possible is AMD's new Raven Ridge APUs, specifically the Ryzen 3 2200G. Here is an APU that packs a semi-decent graphics processing unit alongside a quad-core chip for just $100. That it also happens to net you a decent little air cooler as well is just more reason to be impressed by the crazy value for money on offer. It doesn't take much more hardware to turn that most budget of AMD chips into a useful system.

So, what can you do with a modern AMD APU? Pretty much anything you want, bar high-end gaming. It'll handle older games with only the subtlest of tweaking, and even give newer games a good try. Those four cores mean it can handle processor-intensive tasks well enough, but if you're looking for workstation levels of performance from a budget chip, we've got some bad news: you still get what you pay for, and for serious power, you're going to have eye up the higher echelons of the Ryzen stack (and cough up for a graphics card).

BUILDING TO A TIGHT BUDGET

WITH THE PROCESSOR SELECTED, the rest of the component selection is simply a case of assembling budget-conscious hardware to make our chip of choice truly shine. The main component to focus on here is the RAM, because Ryzen APUs love a high-speed memory bus. Not only does the CPU get more bandwidth to play with, but the graphics side of things can strut its stuff so much faster because of it. This is why we grabbed the 8GB kit of Corsair Vengeance LPX DDR4-3000 memory, which just so happens to be the most expensive component in this whole build. Yup, more expensive than the processor itself.

You obviously also need a decent motherboard to make the most of these two, and here we reached for MSI's value-tastic MSI B350 PC Mate. For a budget board, it manages to pack in a lot of great features, including isolated audio circuitry, with separate layers for left and right channels, USB 3.1 Type-C, and support for M.2 drives at up to 32GB/s. Not that our budget extends to an M.2 drive, but the option is there. Which brings us nicely to the storage side of things: We've elected to use the same storage for the Intel and AMD builds, which is made up of a 120GB Kingston SSDNow UV400 and a 1TB Western Digital Caviar Blue drive. Giving plenty of storage for applications and data, as well as speedy storage for the operating system.

That leaves the last two components of our build: the chassis and the power supply. Zak was suitably impressed with the budget-conscious MasterBox Lite 5 from Cooler Master (see the full review on page 85), and while it's not the cheapest box you can throw your machine in, it has plenty of great features that make building in it a good experience. The Corsair power supply, meanwhile, offers great value for money, at just $24 for this 450W model.

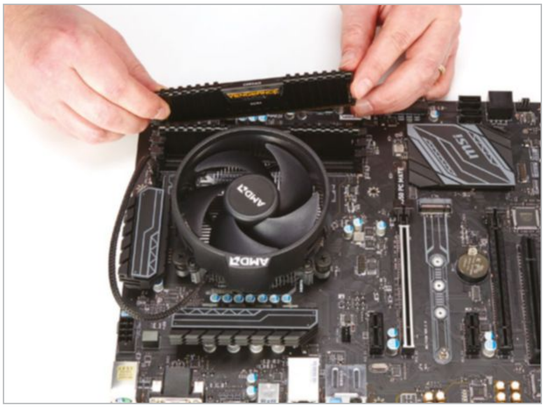
AMD INGREDIENTS

PART		STREET PRICE
Case	Cooler Master MasterBox Lite 5 RGB	**$70**
Motherboard	MSI B350 PC Mate	**$80**
CPU	AMD Ryzen 3 2200G	**$100**
Memory	8GB (2x 4GB) Corsair Vengeance LPX DDR4-3000	**$110**
PSU	Corsair CX 450W	**$24**
Storage 1	Kingston SSDNow UV400 120GB	**$51**
Storage 2	Western Digital Caviar Blue 1TB	**$47**
Total		**$482**

1

TESTING TIMES

DIFFERENT BUILDERS GO about making sure their hardware works in different ways, but we're fans of ensuring the core components work fine outside of the case. We do this by plugging the RAM, CPU, and cooler in place, before attaching the power supply and shorting the power pins to make sure it boots up. Attach a monitor to the video out, and you should find yourself looking at the BIOS screen. You'll need to attach your keyboard and mouse if you want to make any changes, and now is also a good chance to update the BIOS—which we did here by downloading the update on another machine, before transferring it on to a USB stick, and updating from there.



2

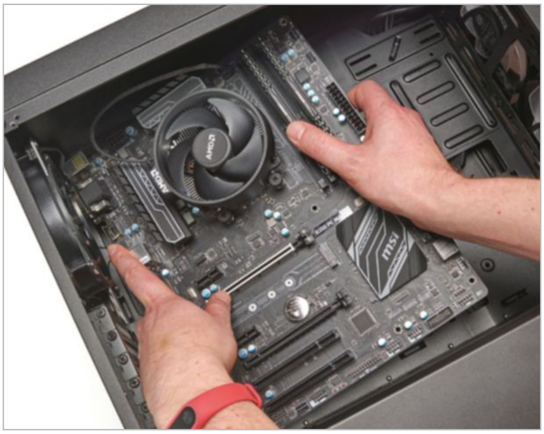
MULTIPLE STAND-OFFS

THE COOLER MASTER MasterBox Lite 5 RGB supports both ATX and ITX builds, and as such only has two motherboard stand-offs installed by default. Our MSI motherboard is a full ATX design, which means you'll need to screw the other seven stand-offs into place if you want your motherboard to be secure and fit for moving around. Cooler Master includes a small adapter in the box to make screwing these stand-offs into place easy using a standard Phillips screwdriver. The positioning of these is clearly marked on the motherboard tray, although it's worth checking that your motherboard lines up properly with them if you've selected a different motherboard.

3

DROPPING IN

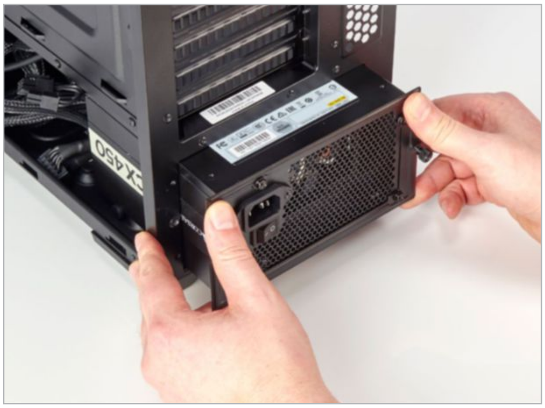
DISCONNECT THE POWER SUPPLY from the out-of-box-testing setup from step one, then ease the motherboard into place so that it sits on top of the stand-offs you've just attached. Don't forget to pop in the rear IO plate beforehand, though—it clicks neatly into place when it's properly inserted. You need to angle the motherboard so that it connects with this. Once done, it's simply a case of screwing the motherboard into place using the supplied screws. It's worth making sure that the case's front panel connector cables don't get trapped under the motherboard as you're doing this.



4

POWERING UP

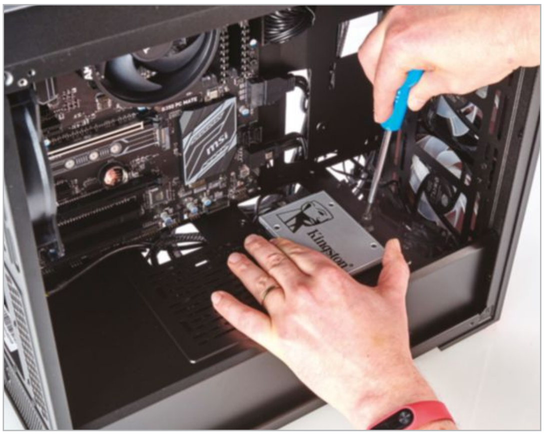
DESPITE BEING A BUDGET CASE, the Cooler Master chassis has some neat touches, including a mounting bracket for the power supply, which makes installing your PSU that much easier. Essentially, you release the bracket from the back of the case using the pair of thumbscrews, screw this plate on to the back of your power supply (making sure to get the orientation right, so that the PSU fan is pointing downward), and then slide it into place. Because this is a non-modular supply, you'll want to bundle up the cables, thread them into the machine, and make sure they aren't catching on anything first. Finish by securing the PSU using the thumbscrews on the plate.



5

DRIVE TIME

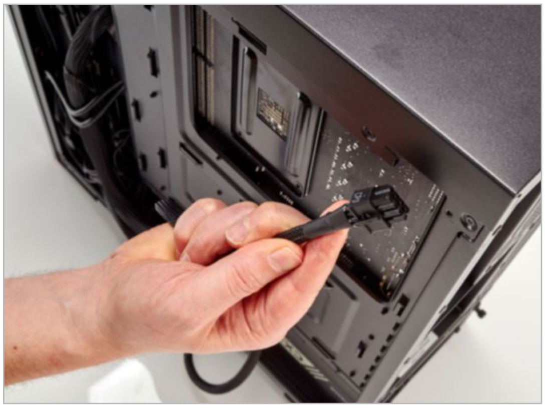
BEFORE WE START connecting those power supply cables, now is a good time to work out where your drives are going to go. The MasterBox Lite 5 has room for a pair of 3.5-inch hard drives at the back of the machine, and the brackets for housing these are easy to use. When it comes to the SSD boot drive, there are plenty of mounting options. You start by securing the drive to the mounting bracket, then clipping it in place wherever you deem is best. Here we've decided to place it above the power supply, where it'll be on show through the case's window. Secure it with the thumbscrew, and you're good to go.

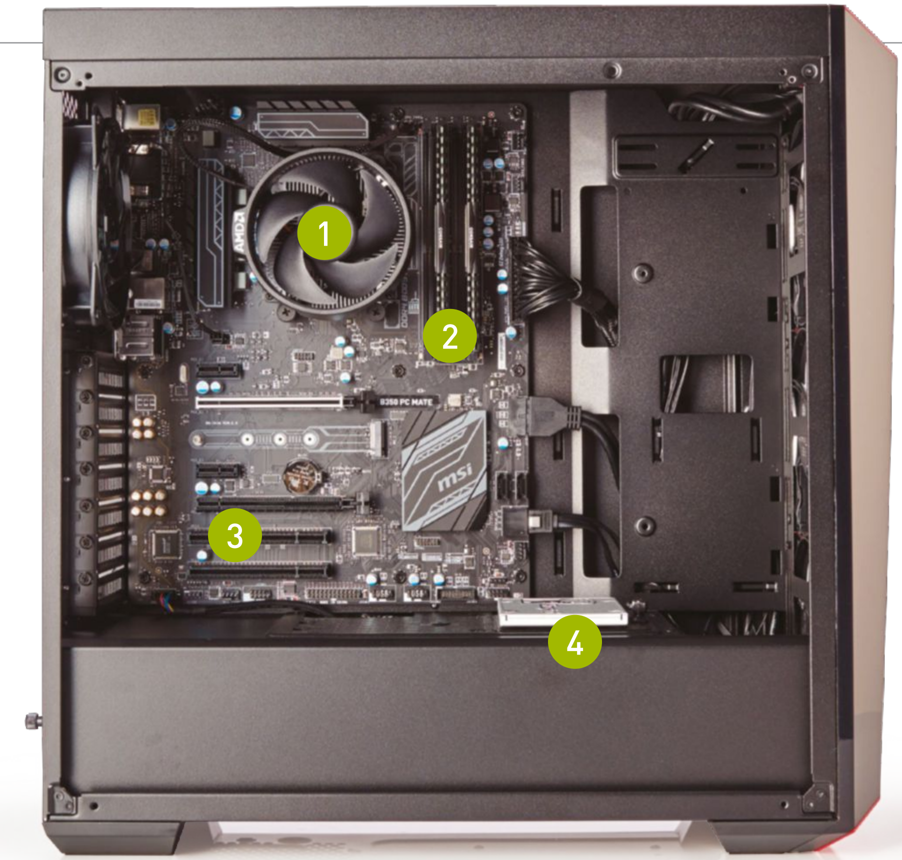


6

CABLE GUY

ALL THE COMPONENTS are now in place, so it's time to start connecting everything up. There's plenty of room in this case to route your cables, and even attaching the often-tricky eight-pin CPU cable isn't too difficult. Simply thread it out of the back of the machine, and route it up behind the motherboard tray, before threading it back through the top corner. You can then clip the cable in place before taking up the slack and securing it in the PSU bay. The other cables are straightforward to connect, and don't forget the front panel connectors, or the case's four fans. You can hold cables in place using the wealth of cable ties that come with the case as well.





1 The Wraith Stealth Cooler that comes with the chip does a great job of cooling the Ryzen 3 2200G while keeping the noise levels down. Mounting it is easy enough, too.

2 The Corsair Vengeance DDR4 RAM may be rated at 3,000MT/s, but the fastest XMP profile tops out at 2,933MT/s. Still plenty fast enough for our Ryzen to strut its stuff.

3 There's plenty of upgrade potential on offer with this build, with room for a speedy M.2 drive, plus plenty of slots for a graphics card, and any expansions you want to add.

4 The mounting system for the SSD enables you to quickly and easily position it in the perfect place for your build. There are two slot locations on top of the PSU divider, and another two to the right of the motherboard.

BUDGET BRILLIANCE

AS FAR AS BUILDS GO, this was reassuringly smooth. There were no horrible surprises, and aside from one small mishap with the internal USB 3.1 cable (we'll come to this shortly), it probably goes down as one of the easiest builds we've ever undertaken. Checking that all the components were working outside of the case before we started the main build meant that we had the peace of mind of knowing that we didn't have to strip it all back again in case something went wrong.

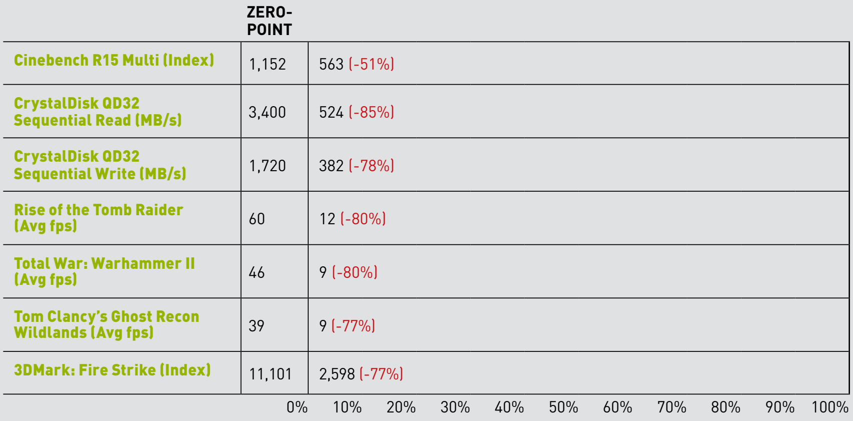
One thing to watch out for when you're building a Ryzen 3 2200G or Ryzen 5 2400G machine is that you need to use a motherboard that has an up-to-date BIOS, so the graphics output will work straight from the box. If you are using an older motherboard, you need to flash the BIOS first using another chip. We had a Ryzen 7 1800X and a GeForce 1080 Ti on hand just in case, but in the end, didn't need them. We did need to flash the BIOS to get the most from the RAM, though, because prior to updating it, we couldn't get it to boot with either XMP profile.

We have to applaud Cooler Master for the case—it boasts a number of features that made this build smoother than it otherwise would have been. The separate section for the power supply, the hard drive caddies and SSD mounting plate, and great open-plan design meant that we weren't trying to work in tiny, cramped sections, as we sometimes do. One thing of note is that we couldn't get the fans to light up with this motherboard, despite the fact that it had an LED header. They do their main job fine, just without a light show.

As for the USB 3.1 cable problem, this was actually down to how we photograph the machine and write these articles. Basically, it means that the machine is built and stripped down several times in the process. And in one strip-down, we were a bit too giddy with the internal USB cable, and managed to break the house of the socket as we unplugged it. A touch of glue fixed this quickly enough, but it's still worth being careful around those right-angle mounted brackets.

In performance terms, there's a lot of bang for your buck with AMD's new chips, and while the frame rates are low in our games, it's worth noting that these tests are carried out at the highest "Ultra" settings, and playable frame rates are possible at lower settings. Overall, we've been impressed by how easy it is to put this system together, and how well it performs. Despite everything, it's still a great time to put a budget AMD rig together.

BENCHMARKS



	ZERO-POINT	
Cinebench R15 Multi (Index)	1,152	563 (-51%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	524 (-85%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	382 (-78%)
Rise of the Tomb Raider (Avg fps)	60	12 (-80%)
Total War: Warhammer II (Avg fps)	46	9 (-80%)
Tom Clancy's Ghost Recon Wildlands (Avg fps)	39	9 (-77%)
3DMark: Fire Strike (Index)	11,101	2,598 (-77%)

Our zero-point consists of an AMD Ryzen 5 1600 @ 3.2GHz, 16GB Crucial Ballistix Sport LT @ 2,666MT/s, EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

BUILD IT

ZAK STOREY, DEPUTY EDITOR

Intel Epiphanies in Economy

Facing up to its AMD competitor is this lean, mean, not green, slightly OK office machine

LENGTH OF TIME: **1–2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

THESE BUILDS have been an interesting exercise in budgeting, that's for sure. We usually work at the crazy end of the system-building spectrum here in the labs, and as we've mentioned in the past, it's far easier to get expensive components in than more affordable gear. Which, although truly hysteria-inducing at times, makes working on a project like this far more satisfying.

That said, this isn't the first time we've looked at such affordable rigs. Back in March 2017, we were given a $300 budget, and told to tackle a similar challenge, albeit with 8GB of DDR3, a 256GB SSD, and some terrible, terrible, terrible processors. No, seriously, just how far things have come in processing performance in the last year is staggering. But more on that later.

So, what was the idea behind these two projects? In short, to keep things simple. Build two systems with a suitable upgrade path, and plenty of grunt to drive some modern 1080p titles, at medium settings or so. And to do it without breaking the bank. As memory and GPU prices have skyrocketed over the last two years, the game has changed significantly when it comes to pricing up rigs like this, and that $300 budget that we once strived for is—today, at least—a complete non-starter.

Admittedly, we haven't included the price of the OS with these machines, because we're focusing more on the hardware, but you can pick up Linux for free, and an OEM copy of Windows 10 is pretty cheap nowadays. Anyway, now the waffle is out of the way, let's break down just what went into this very special Intel build.

THE BUDGET BUSTER

LET'S BE FRANK, there's not a huge amount of difference between our two builds. Spec for spec, they're both fitted out with a similarly priced processor, similar memory, and like-for-like storage. Yet it's the small details, the less-performance-affecting choices we've made, that really separate the two systems.

The most obvious being the two cases. Going up against the AMD build's Cooler Master MasterBox Lite was always going to be a challenge. With its absolutely absurd arsenal of modern-day features, including three RGB front fans, colored accents, tempered glass, and stellar internal layout, we needed something that could give it a fair run for its money. The BitFenix Nova TG brings that fight down hard. Coming in at a street price of $50, it's 20 bucks cheaper than its competitor. Featuring an old-school internal layout, tons of room for storage, and a seriously slick tempered glass panel, BitFenix hasn't held back when it comes to kicking. Airflow could be better up front, but given how little heat we expect this machine to produce, there's an argument to be had for not needing it that much anyway, at least until you decide to upgrade at a later date.

Apart from the case, we also opted for a slightly pricier PSU, courtesy of EVGA, and some lower spec DDR4, to save a few bucks, purely because higher frequencies wouldn't particularly benefit this Intel rig in any meaningful way. Although it's not included in the pricing, using the remaining budget we snuck in a nice magnetic white 12-inch LED strip running along the top of the case as well, just to make it pop a little more. It's a small luxury, using a little extra cash, and completely superfluous, but we may as well take advantage of that tempered glass side panel while we have it.

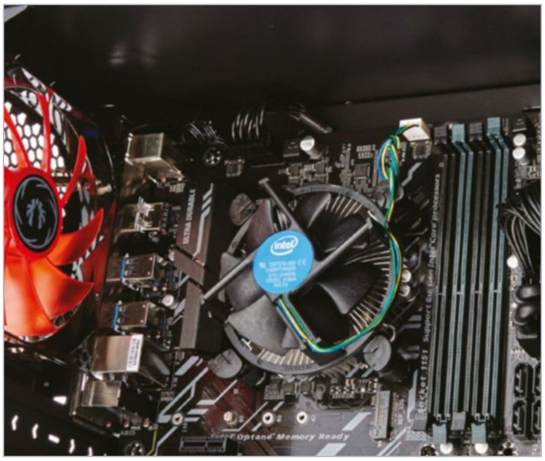
INGREDIENTS

PART		STREET PRICE
Case	BitFenix Nova TG	$50
Motherboard	Gigabyte Z370P D3	$96
CPU	Intel Core i3-8100	$114
Memory	8GB (2x 4GB) Team Vulcan DDR4-2400	$96
PSU	EVGA BT 450W	$28
Storage 1	Kingston SSDNow UV400 120GB	$51
Storage 2	Western Digital Caviar Blue 1TB	$47
Total		$482

1

STOCK COOLING

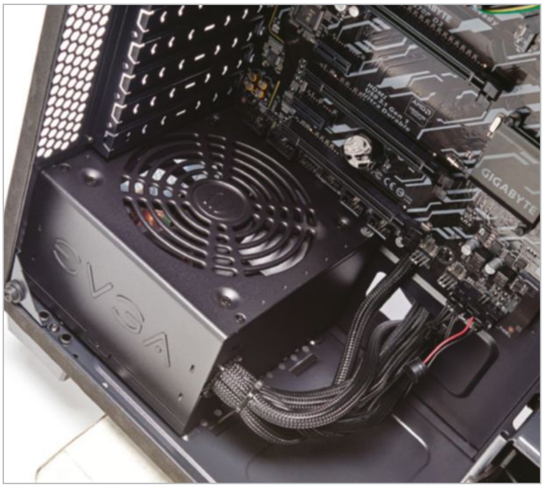
INTEL'S STOCK COOLER design hasn't changed too much since its inception with the early Nehalem processors. Simply open up the locking mounts on each corner, push the cooler down through the holes on the motherboard until it clicks into place, and then lock by turning each thread counter-clockwise. We're sticklers for consistency on this build. A smart way of keeping the cable tidy is to tie a small loop into the header, then plug it into the motherboard's CPU fan header. It looks far cleaner, and keeps it out of the way of any conflicting fans.



2

INTERNAL CHILLING ON A BUDGET

UNFORTUNATELY, unlike our competing AMD build, we don't have the luxury of running triple fans in the front of the rig for maximum airflow. So we've opted to go a little old school and instead throw the PSU fan upward. This will draw air from the chassis, use it to cool the PSU, then dump it out the rear of the case. It's not ideal for liquid-cooled builds, or if you're running a particularly hot rig, but for our low thermal producing components, it should help keep air flowing at little cost.



3

RETRO TIME

OUR EDITOR SAID we weren't getting hands-on enough in the photography for this "Build It," so we decided to take it up a notch, and point at this speaker. As we've gone for such a cheap Z370 board, having access to this little beauty helps us to diagnose any errors on the board. Beep. One good thing about Gigabyte's mobos is the included front I/O header mounting bracket: Simply thread your front panel connectors into the designated holes on the bracket, let them click into place, then carefully push the bracket on to the front I/O pins on the board. Our testing found that this reduced unnecessary cussing by a staggering 268 percent throughout the duration of a building session.

4

NOT QUITE ATX?

UNFORTUNATELY, there's still some variance with ATX motherboards, especially at the budget end of the spectrum, with most ATX mobos actually being about half an inch shorter than the full ATX standard. This means you'll often find your mobo can't be secured across all of the ATX stand-offs in a chassis. This can make it particularly difficult when installing memory and the 24-pin ATX power on the motherboard, because you risk warping the PCB. We can only suggest you do as much as you can outside of the case first, and even install the 24-pin with the motherboard on a box first, before you install it into the chassis.

5

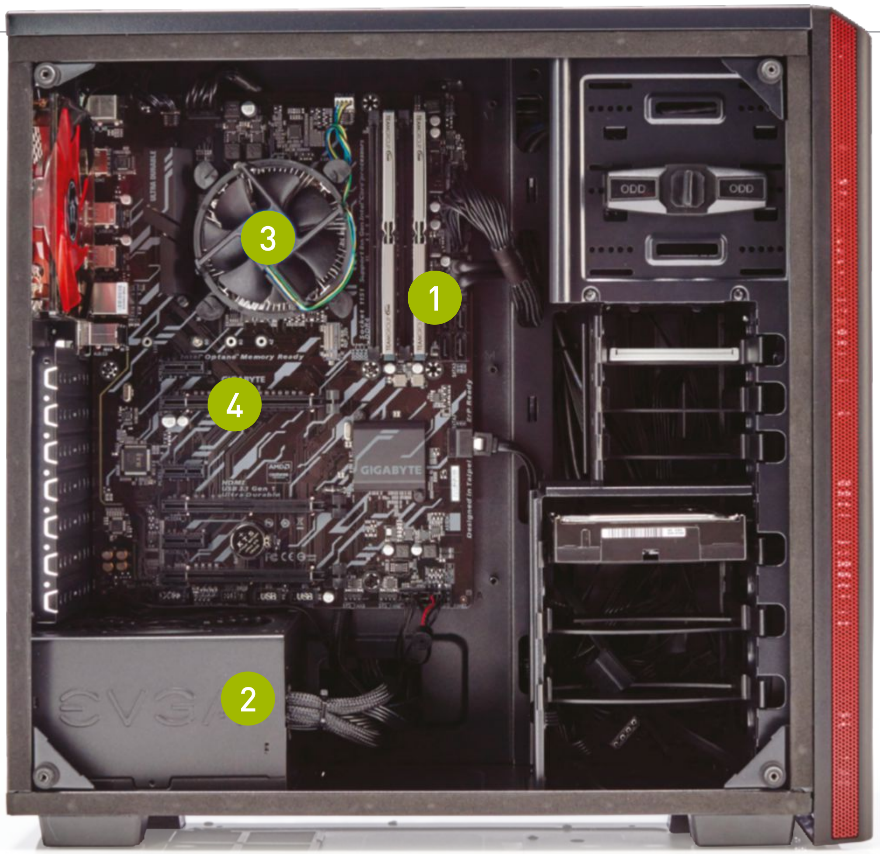
LIGHT UP YOUR LIFE

THE ONE THING that isn't budgeted for in our rig is the LED strip running along the roof, which we've discreetly hidden. If we're honest, it was a last-minute decision to throw this in (literally pulled out of Dream Machine 2017), just to show off the internal components, and how clean we managed to make the build, even on a budget. You can pick one of these up for around $20, and it even comes with an adhesive back, in case your chassis isn't magnetic.

6

CABLE FRIPPERY

WE'VE GOT a pretty hefty CPU power cable on our 450W EVGA PSU, which means it's a real struggle to fit it through the top pass-through in the case, and secure the motherboard down. To get around this, we've carefully positioned it below the motherboard, ahead of time, before securing it into place, keeping it tidy and out of the way. On top of that, we've kept our cables neat by tying several of them together. You'll notice our ATX power and front panel headers are bound together, along with the bundled front fan and SATA power, and the GPU and additional Molex power that we didn't need are bound at the bottom, then hidden in the hard drive cage. This keeps the cables taut, tidy, and out of the way, without necessarily tying them to the chassis itself.



1 Team Group is not a brand we usually go with, but as its memory, at a fairly commonplace frequency, comes with a nice heatsink, why not?

2 EVGA's $28 450W PSU comes with a sleek design and entirely black cables. Now, that's what we call epic.

3 Intel's stock cooler is certainly good enough to cool its lineup of low-powered chips, although it pales in comparison to the likes of AMD's Wraith cooler.

4 Obvious upgrades for this rig would be a GTX 1050 Ti or higher, and potentially an M.2 SSD as well—then we'd be cooking.

CUT-PRICE PERFORMANCE

WHEN IT CAME TO putting our budget Intel build together, not a lot went wrong. It was pretty much plug and play. We did have a slight issue installing the eight-pin EPS power at the top of the board, but that was quickly resolved by running the cable under the motherboard itself. It's a pretty neat fix, although admittedly not one we have to do very often. We could have perhaps dodged this entirely simply by installing the PSU with the fan facing downward, but losing that additional airflow pull-through would have been detrimental to overall temps. Perhaps, if we'd grabbed an additional 120mm fan for the front, we would have considered it, but this was the best way to run it as things stood.

The other bugbear we had to deal with was the incompatibility with the stand-offs. Yep, the Z370P D3 is labeled as an ATX board, but it's simply not wide enough to fit on the additional ATX stand-offs in the chassis. That's not an issue with the case, more with the board. Even if the PCB lacked any additional features, we'd like to see a consistent size for the form factor—after all, it's not much of a form factor if it doesn't conform across standards, at least with the stand-offs.

The biggy with this rig is performance. Obviously, this system was going to be demolished by our budget zero-point—that's $1,100 of kick-ass hardware, including a six-core Ryzen 5 processor, a GTX 1060, and a Samsung 960 Evo—but showing that is a good example of the price-to-performance sweet spot. It's something that sits in the middle, between the absolute high and low ends of hardware. There's a point where you'll end up with diminishing returns in both directions; after all, for twice the cost, you get a hell of a lot more than twice the performance in almost all scenarios, bar computational tasks, and that's pretty insane.

In a similar vein, this Intel build has taught us how incredible the Ryzen proposition is. Take the APU in the AMD build on page 64—the difference in graphical performance is staggering, especially when you're on a budget. But even ignoring that, we've been referring to the Core i3-8100 as possibly the most important CPU in Intel's latest line-up, essentially performing like a Core i5-6600K, but at a fraction of the cost. The thing is, against the Ryzen 5 1600 featured in our zero-point machine, both look like paperweights, because the 1600 nearly doubles the performance in comparison, but for the same money as that i5 today. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,152	541 (-53%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	540 (-84%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	372 (-78%)
Rise of the Tomb Raider (Avg fps)	60	5 (-92%)
Total War: Warhammer II (Avg fps)	46	3 (-93%)
Tom Clancy's Ghost Recon Wildlands (Avg fps)	39	2 (-95%)
3DMark: Fire Strike (Index)	11,101	1,183 (-89%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 5 1600 @ 3.2GHz, 16GB Crucial Ballistix Sport LT @ 2,666MT/s, EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

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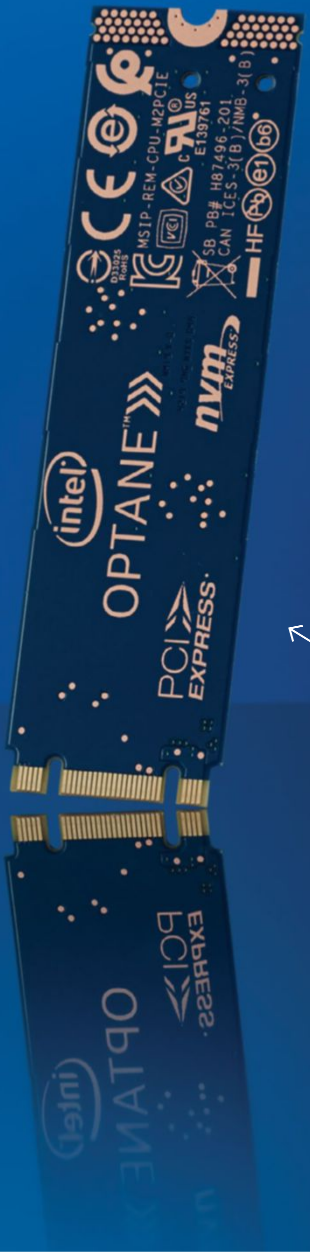


INTEL OPTANE SSD 800P 118GB
PAGE 80

INSIDE

74 Asus ROG Strix GL503VS-DH74 Scar Edition

76 AMD Ryzen 3 2200G

79 MSI B350i Pro A/C

80 Intel Optane SSD 800p 118GB

82 LG 27UD88

85 Cooler Master MasterBox Lite 5 RGB

86 Roccat Horde AIMO

87 SteelSeries Rival 600

89 Roccat Khan AIMO

90 Kingdom Come: Deliverance

91 Metal Gear Survive

92 Lab Notes

ASUS ROG Strix GL503VS-DH74 Scar Edition

From zero (point) to hero

IF THE NUMBERS on the Asus ROG Strix GL503VS-DH74 Scar Edition look familiar, that's because they should. This is the newer version of the GL502VS-DS71, the system we use for our laptop zero-point. It's largely the same build, but with a few tweaks and upgrades. Unfortunately, it's also a tad more expensive.

To start with, the GL503VS is a 15.6-inch laptop with nearly identical internals to its older brother. Intel's Coffee Lake CPUs haven't made it to laptops just yet, so the GL503VS still sports a Core i7-7700HQ clocked at 2.81GHz. Cinebench scores reflect this, with the GL503 topping the zero-point in the single-core test, but barely lagging behind when all the cores are engaged. This is a trend we'll see across most of the Scar Edition's scores—similar or slightly worse performance to the zero-point (we'll get into gaming scores later), though in our opinion for good reason.

The most logical reason for the slightly worse scores is due to the GL503's smaller frame. Our zero-point measures in at 1.2 inches thick, whereas the updated system is 25 percent thinner, at just 0.9 inches. The size and weight difference is noticeable, and makes slipping it into a casual backpack much easier. If the cost is ever so slightly worse thermals, and thus just a point or two difference in benchmarks, that's a trade we'll take.

Other upgrades can be found in the screen and storage solution. For the former, the 1080p G-Sync panel moves from 120 to 144Hz—a nice little bump. As for the latter, the primary SSD upgrades from a 128GB SSD to a much snappier 256GB NVMe solution. This is paired with a 1TB FireCuda SSHD that performs well for media and larger game installs.

On the gaming front, the GL503VS packs an Nvidia GeForce GTX 1070 (again, same as the zero-point), and logically offers near identical—though very slightly worse (again, likely due to the reduced chassis size)—gaming performance. *Rise of the Tomb Raider* fell from 99 to 91fps across the three-part benchmark, for example, but *Total War: Warhammer II* and *Ghost Recon: Wildlands* both only lost a single frame off the zero-point score, at 60fps and 48fps, respectively.

These are all respectable scores, considering we run our tests on the highest available graphics preset, and *Ghost Recon* is especially demanding. But where the GL503VS really shines is in slightly less demanding shooters, such as *Overwatch.* The high refresh rate screen (and G-Sync) is perfect for fast-paced twitchy shooters, and gameplay remained smooth with 100-plus frame rates.

This makes sense, as Asus markets the GL503VS Scar Edition as "optimized to gain a competitive edge in FPS titles." To that end, the keyboard does feel good and responsive, and comes with N-key rollover. We did have a gripe with the touchpad, though—it sometimes failed to recognize two-finger scrolling around the edge. A bit annoying, but a non-issue for gaming, as you'll (hopefully) use an external mouse.

All in all, the GL503 is a nice upgrade over the GL502, despite the slightly lower benchmarks—especially if you appreciate the added portability. The question is whether it's worth the extra money. If it were just the screen and chassis that improved, it'd be a hard sell, but combined with the additional SSD size and performance, it's worth it. **–BO MOORE**

VERDICT **8**

Asus ROG Strix GL503VS-DH74 Scar Edition

➕ **BATTLE SCARS** Great screen features; slimmer than most; nice SSD.

➖ **TRENCH FOOT** Iffy touchpad; same performance can be had for cheaper.

$1,899, www.asus.com

BENCHMARKS

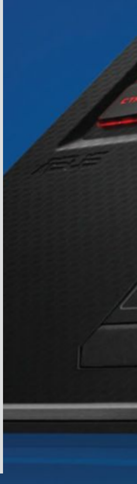
	ZERO-POINT	
Cinebench R15 Multi (Index)	743	739 (-1%)
Cinebench R15 Single (Index)	155	160 (3%)
CrystalDisk QD32 Sequential Read (MB/s)	563	3,275 (482%)
CrystalDisk QD32 Sequential Write (MB/s)	133	1,152 (766%)
PCMark 10 Express (Index)	3,852	4,228 (10%)
3DMark: Fire Strike (Index)	48	48 (0%)
Rise of the Tomb Raider (fps)	13,202	13,351 (1%)
Total War: Warhammer II (fps)	99	91 (-8%)
Tom Clancy's Ghost Recon: Wildlands (Avg fps)	62	60 (-3%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our laptop zero-point is the Asus GL502VS-DS71, with an Intel Core i7-7700 HQ, 8GB GTX 1070, and 16GB of DDR4-2400. All game tests are performed at 1080p at the highest graphical profile.

SPECIFICATIONS

Processor	Intel Core i7-7700HQ @ 2.8GHz
Graphics	Nvidia GeForce GTX 1070 8GB
RAM	16GB DDR4-2400
Screen	15.6-inch 1080p 144Hz IPS-like with G-Sync
Primary Storage	256GB PCIe NVMe SSD
Secondary Storage	1TB FireCuda SSHD
Keyboard	Aura RGB lighting, 1.8mm key travel, N-key rollover
Battery	Four-cell 64WHr
PSU	180W power brick
Total Weight	5.6lb



The GL503VS Scar improves on our zero-point with a great screen and slimmer waist.

AMD Ryzen 3 2200G

Is this APU all the chip a budget builder needs?

BUDGET BUILDERS have never been so spoiled. Not in every component choice—RAM and graphics card prices are still hideous—but definitely when it comes to processors. We've never had it so good. After years of marginal performance increases, we find ourselves handling chips that would have been highend a year ago. We're talking quad-core as standard, at decent stock frequencies, with capable integrated graphics. And in the case of this new $100 chip, that latter point shouldn't be understated.

The Ryzen 3 2200G, like the 2400G that we looked at last issue, uses architecture more readily found on AMD's discrete graphics cards to power the chip's 3D graphical grunt. Where the top-end Vega 64 has 64 compute units, and the 2400G has 11, here we're dealing with just eight. That equates to a core configuration of 512 unified shaders, 32 texture mapping units, and 16 render outputs. Not heady numbers in terms of add-in graphics cards, but not bad for an integrated solution.

In real terms, this means you're looking at 30–60fps in reasonably up-to-date games at 1080p, with sufficient tweaking of the game settings. We managed to hit a fairly smooth 60fps in *Overwatch* using the medium game settings, while we had to drop to low settings in *Rise of the Tomb Raider* in order to hit an average 35fps. The integrated graphics on offer here aren't going to challenge any serious discrete offering, but they are powerful enough to let you play modern games at a fraction of the price—a compromise many of us are willing to make.

In terms of raw processing, the Ryzen 3 2200G is surprisingly powerful, given its low cost. That C-note nets you a quad-core processor running at a tasty 3.5GHz, with a max turbo of 3.7GHz. And it will happily hit that max turbo a lot of the time, as well. It's worth noting that because this is designated a Ryzen 3 processor, it doesn't pack any multithreading cleverness, so those four cores equate to four threads, but still, that isn't bad for a budget chip.

The Ryzen 3 2200G replaces the Ryzen 3 1200 that precedes it, squeezing a graphics core into its AM4 package and upping the operating frequency, while keeping the price pretty much the same (you can pick up the 1200 for $95 at the moment). Part of the reason for the upping of the operating frequency is down to the fact that the first generation chips use two core complexes, each with a pair of working cores, while the 2200G uses just a single core complex with a full quad-core make-up. The downside of this is that there isn't as much L3 cache—4MB down from 8MB—although the latency is improved, so you may not notice this drop in day-to-day usage.

As the Ryzen 3 1200 is being retired, that leaves two chips for any budding budget builder to pick from—the 2200G and the 1300X, the latter costing $125. A quick look at the performance table reveals that the 2200G has the edge over its more expensive sibling in all but one test, but that particular test is important because it highlights the one downside of the new chip: the drop from 16x PCI Express lanes down to 8x, to make way for the integrated graphics. This drop in bandwidth shouldn't be an issue apart from at the very high end, but it is something worth bearing in mind if that's your ultimate goal.

Performance-wise, the 2200G loses out to Intel's Core i3-8100 in straight processor testing, but it does have the upper hand when it comes to integrated graphics performance. Which means that if you want to play the odd game, but don't want to drop serious cash on a separate graphics card, then this new budget chip from AMD is the way to go. If gaming is of no interest to you at all, though, or you're definitely going to go down the discrete graphics route, then the Intel chip has the edge over the Ryzen. It's great to have genuine options once again. **–ALAN DEXTER**

VERDICT
9

AMD Ryzen 3 2200G

+ UNITED Great value for money; powerful integrated graphics; fast clocks.

− DIVIDED Limited max PCIe lanes; needs speedy RAM; no multithreading.

$100, www.amd.com

BENCHMARKS

	AMD Ryzen 3 2200G	Intel Core i3-8100	AMD Ryzen 3 1300X
X265 Benchmark (fps)	13.16	**14.32**	12.64
Cinebench R15 Single (Index)	143	**154**	139
Cinebench R15 Multi (Index)	564	**601**	550
Fry Render (Seconds)	420	**388**	462
AIDA64 Memory Latency (ns)	68	**63**	78
Total War: Attila (fps)	36	**40**	36
Far Cry Primal (fps)	72	**77**	73
3DMark: Fire Strike (Index)	13,200	**15,237**	14,152
Power Draw Idle (Watts)	45	**43**	56
Power Draw Load (Watts)	111	112	**95**

Best scores are in bold. Our test bed consists of an Asus Maximus X Hero (Intel) or MSI X370 Gaming Pro Carbon (AMD), 16GB (2x 8GB) of Corsair Dominator Platinum DDR4, an Nvidia GeForce GTX 1080, and a Samsung 850 Evo 500GB SSD. All games were tested at 1440p on the highest graphical profile.

SPECIFICATIONS

Base Clock	3.5GHz
Turbo Clock	3.7GHz
Core/Threads	4/4
Lithography	14nm
Cache	4MB L3 (2MB L2)
Memory Support	DDR4-2933
Memory Channels	2
Max PCIe Lanes	8+4
Graphics	Radeon Vega 8
Graphics Clock	1,100MHz
TDP	65W

AMD Ryzen 3 2200G
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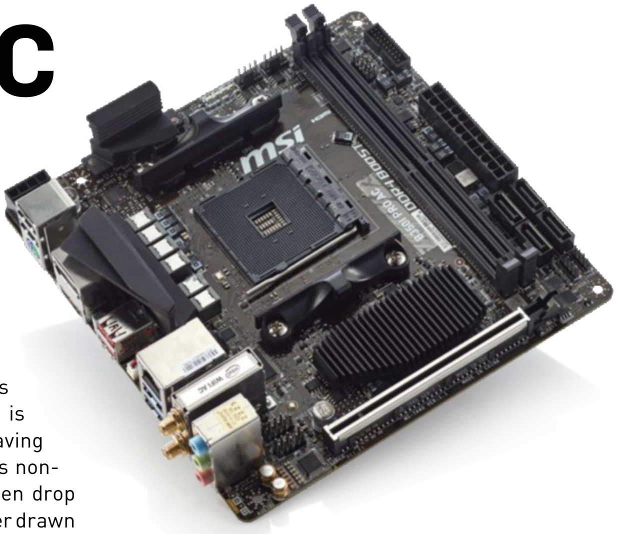
MSI B350i Pro A/C

Budget buster beats the bosses



AN ITX RYZEN MOBO, with a fantastic overclocking solution, and a kick-ass feature set, all on the B350 chipset. Wait, what? Yep, that last part throws a curve ball. The understated brown PCB, the sub-high-end chipset, the simple, unsophisticated black heatsinks—it all mars an otherwise fantastic assembly of prime components designed to push the Ryzen ITX form factor to new heights.

What's so good about the B350i Pro AC? It all comes down to the power-phase design. There are nine phases in total here (with the closest competing ITX board housing a meager six in contrast), which helps provide the additional grunt needed to balance the power from that Ryzen core. As soon as you start to take a look at those performance numbers, it's obvious how big a difference this has made. At stock, the MSI B350i Pro topped our X265, Cinebench R15 Multi, Fry Render, and AIDA64 memory latency scores across every Ryzen board we've ever tested by quite a margin. So much so, in fact, that we had to double-check our testing methodologies to make sure nothing was awry.

We've never seen anything quite like it. Generally, when you get these kind of scores in motherboard testing, the dead giveaway about what's going on is shown in the power draw figures. And, sure enough, peak draw testing puts the B350i Pro second highest, coming second only to the Gigabyte AX370-Gaming 5, drawing a hefty 172W from the wall, compared to the AX370's 197W. There's not a huge difference between this and the other boards below it (about 4W at most), but it's enough to identify what's causing these higher figures at stock. And that's the stock Turbo performance.

Traditionally, Turbo clocks only kick in when a processor is under load. It's a smart way of saving power when the core's workload is non-existent. No tasks under way? Then drop the frequency, and reduce the power drawn from the wall. Under load, the processor then ramps up the core frequency across all of its cores to the max safe operating parameters set out by the manufacturer.

With Ryzen, AMD introduced a new form of Turbo tech known as XFR. In short, depending on the task at hand, and if temperatures are within the correct boundaries, it auto-overclocks and pushes as many cores as is needed to a higher frequency for better performance. So, you can end up with one core at 4.05GHz in demanding single-threaded applications, or eight cores at 3.9GHz in more challenging multithreaded programs.

So, if a motherboard provides scores meaningfully higher than its competitors in our testing suite, it almost certainly means power draw is up (and it is, in this case), implying the mobo is leveraging temperatures and overclocks better than most. More often than not, because of that increased voltage, temps increase as well. But MSI has seemingly balanced this just right, to get more performance out of the processor without necessarily increasing temperatures by any great degree, with our figures reading, at maximum, around the 65 C mark under load.

Unfortunately, all this VRM wizardry still doesn't translate to a higher maximum overclock (as the architecture is still fairly maxed out as it is), but it does mean that the B350i Pro is a fantastic, almost budget, ITX offering for those looking to get the most out of any Ryzen CPU without tinkering. Power draw is higher than we'd like to see, but not enough to worry us, as those temps are still within reasonable parameters. Connectivity is solid, too. There's nothing not to like about the B350i Pro, except perhaps the brown PCB. **–ZAK STOREY**

BENCHMARKS

	MSI B350i Pro A/C	Asus ROG Strix X370-I Gaming
X265 (Avg fps)	**28.68**	28.31
Cinebench R15 Multi (Index)	**1,644**	1,635
Fry Render (Seconds)	**150**	152
AIDA64 Memory Latency (ns)	**75.6**	76
Power Draw Idle (Watts)	**53**	81
Power Draw Load (Watts)	172	**168**
CrystalDisk Sequential Read (MB/s)	550	**551**
CrystalDisk Sequential Write (MB/s)	490	**530**
Far Cry Primal (Avg fps)	**42**	**42**
3DMark: Fire Strike Extreme (Index)	9,481	**9,600**
Maximum OC Achieved (GHz)	**4.0**	3.9

Best scores are in bold. Our test bed consists of a Ryzen 7 1800X, 16GB (2x 8GB) of Corsair Dominator Platinum DDR4 3200, an Nvidia GeForce GTX 1080, and a 500GB Samsung 850 Evo SSD. *Far Cry Primal* tested on Ultra settings at 4K.

VERDICT
9

MSI B350i Pro A/C

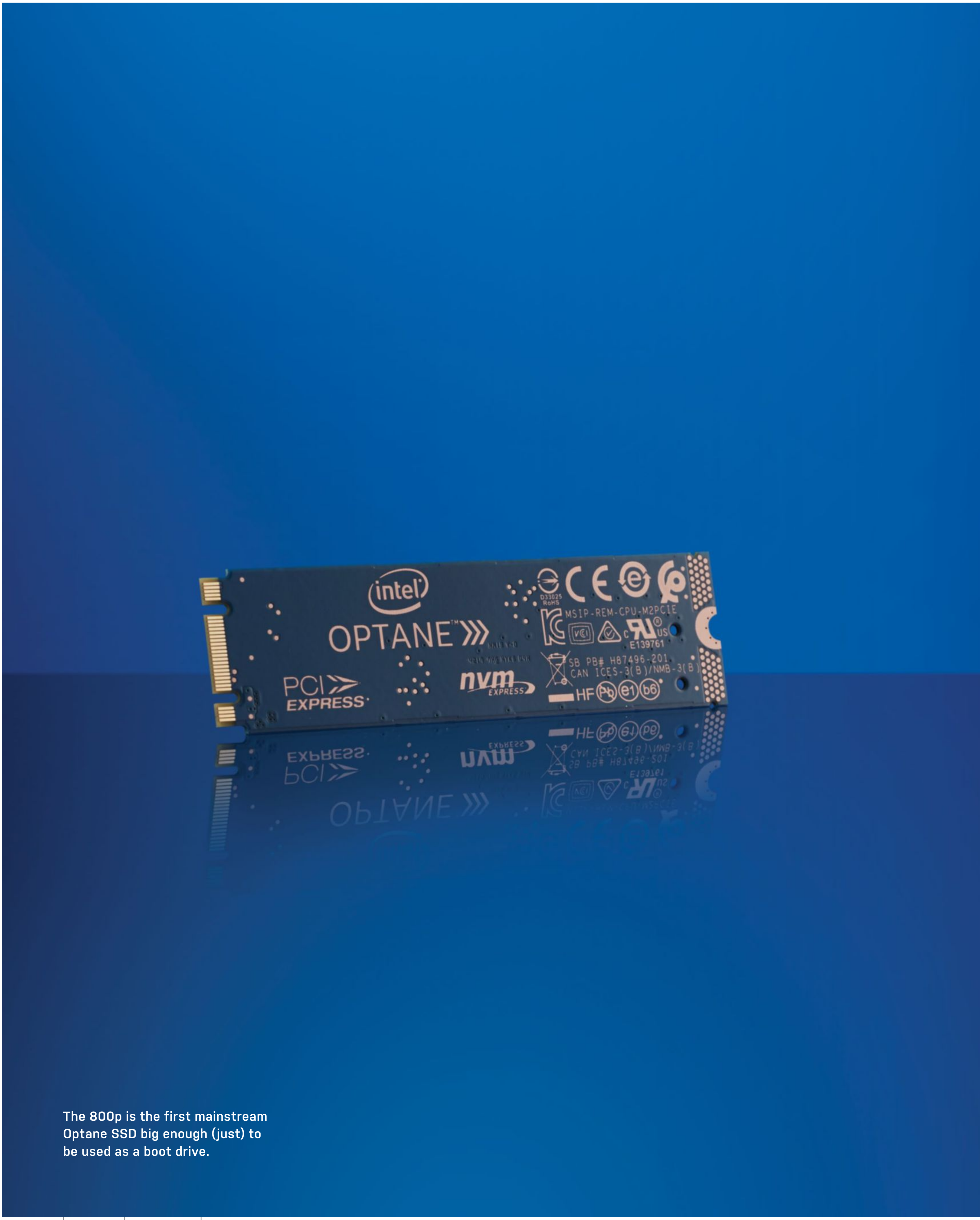
+ **PROGRADE** Fantastic power solution; solid connectivity; good stock performance; price.

− **RETROGRADE** Brown PCB.

$100, www.msi.com

SPECIFICATIONS

Chipset/Socket	B350/AM4
Form Factor	ITX
Memory Support	32GB DDR4 @ 3,200MT/s
M.2/U.2 Support	1x M.2
SATA Support	4x SATA 6Gb/s
Max PCIe Support	1x PCIe 3.0 x16
Rear I/O	Wireless A/C, 2x USB 2.0, 2x USB 3.0, 2x USB 3.1 Type A, 1x DisplayPort, 1x HDMI, 1x Gigabit Ethernet, 2.0 audio out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The 800p is the first mainstream Optane SSD big enough (just) to be used as a boot drive.

Intel Optane SSD 800p 118GB

Intel's revolutionary 3D XPoint memory tech hits the mainstream

TEN TIMES THE DATA DENSITY, 1,000 times faster, 1,000 times better endurance. All of this and more Intel claimed three years ago for its revolutionary 3D XPoint non-volatile memory technology, now branded Optane. Those claims, of course, were made in comparison to the incumbent non-volatile memory tech that dominates the storage industry, namely NAND flash memory.

Now we have our hands on Intel's first more-or-less mainstream SSD for PCs based on that 3D XPoint tech, the Intel Optane SSD 800p. But what's this? Sequential reads of 1,450MB/s? Writes of just 640MB/s? And check out the IOPS, too. Intel rates its new Optane drive at just 250K read IOPS and 140K for writes. Far from being 1,000 times faster than a NAND SSD, all those figures are significantly slower. What's going on?

The short answer is that it's complicated. But before we go for the full debrief, let's square away the rest of the new 800p's specs. At launch, it's only available in two configurations: 58GB and 118GB. Launch pricing is $129 for the smaller drive and $199 for the 118GB drive tested here (which formats down to 110GB). Expensive, small, and slow, you may be thinking. It's not quite that simple, but hold those thoughts.

In many of our benchmarks, the 800p is indeed unremarkable by conventional SSD standards, and a major letdown given the hype that initially accompanied 3D XPoint. Sequential throughput is pretty much in line with Intel's claims, and thus miles off the fastest NAND-based SSDs.

Granted, Intel has gone with a dual-lane PCI Express interface for the 800p, which puts a cap on peak transfer performance compared to high-end NAND drives with quad-lane interfaces, but that's clearly not what is holding back the 800p's sequential write performance, which clocks in at a maximum of 650MB/s in ATTO Disk Benchmark. That's barely any faster than a SATA SSD.

CRYSTAL CLEAR

However, CrystalDiskMark's 4K random access metrics hint at the 800p's greater potential. The 800p registers 229MB/s for reads and 176MB/s for writes. Those figures are substantially faster than the current gold standard among NAND SSDs, the Samsung 960 Pro, can muster. Broadly speaking, then, the focus for this drive is on low latency and low queue-depth performance, not peak throughput.

More specifically, Intel says that the 800p is four to five times faster to respond at short queue depths of one and two compared to a NAND-based SSD. Meanwhile, it's at much deeper queue depths of up to 32 where those NAND drives deliver their fastest 4K random access performance. What's more, Intel reckons it's those shorter queue depths that most determine the performance of typical client PC workloads. Intel also says performance is maintained regardless of how full the drive is, and rates the 800p for 365TB of writes, which is incredibly high for such a small drive.

All told, the new Intel Optane SSD 800p is a bit of a mixed bag. The limited capacity means that even the larger of the two available drives is marginal as a boot drive. It's also disappointing to see a drive based on such a supposedly revolutionary memory technology deliver such mediocre performance by some measures. The consequence is that the upsides of this new technology will have to be qualified, for now. This is, very likely, the most responsive mainstream SSD you can buy. It's also quite possibly the most robust. But it's not the fastest all around.

The extent to which this disappoints probably depends on how much you bought into the 3D XPoint hype. Realistically, it was never likely to completely deliver on the bombastic claims, and even less likely to do so from the get-go. Certainly, it isn't as immediately revolutionary as we were hoping. Of course, 3D XPoint could well still be the future of PC storage, but for now, it feels like a beta technology, albeit one that has us rethinking what is important in a solid-state drive, and how its performance should be measured. **–JEREMY LAIRD**

VERDICT **7**

Intel Optane SSD 800p 118GB

+ FTL DRIVE Ultra-low latency; relatively affordable for an Optane drive; five-year warranty.

− ECONOMY DRIVE Poor sequential performance; limited capacity; expensive given the storage on offer.

$199, www.intel.com

BENCHMARKS

	Intel Optane SSD 800p 118GB	Samsung 960 Evo 250GB	Intel 760p 512GB
30GB Internal Copy (Seconds)	76	89	**66**
Atto Sequential Read (MB/s)	1,453	3,019	**3,048**
Atto Sequential Write (MB/s)	650	1,494	**1,619**
CrystalDiskMark Sequential Read (MB/s)	1,372	1,682	**2,811**
CrystalDiskMark Sequential Write (MB/s)	627	1,475	**1,593**
CrystalDiskMark 4K Read (MB/s)	**229**	64	75
CrystalDiskMark 4K Write (MB/s)	176	191	**218**

Best scores are in bold. Our test bench consists of an Intel Core i7-8700K, an Asus Maximus X Hero, an Nvidia GeForce GTX 1080, 16GB of Corsair Dominator Platinum DDR4, and a Samsung 850 Evo 250GB OS SSD.

SPECIFICATIONS

Capacity	118GB
Interface	PCI Express x2
Control Protocol	NVMe
Controller	Intel
Memory Type	Intel 3D XPoint
Sequential Read	1,450MB/s
Sequential Write	640MB/s
Read IOPS	250K
Write IOPS	140K
Warranty	Five years

LG 27UD88

A pleasing 4K IPS panel at a price

WE LIVE IN AN AGE of ubiquitous technological plenty. Powerful computers in our pockets, near-enough super-computers on our desktops, always-on super-speed connectivity—it's all available, and all quite affordable. But there are one or two areas where compromises must be made at almost any money.

One of those is PC monitors. No matter how much money you throw at a screen, you can't have it all. Take LG's new 27UD88. It weighs in at $700. Pricey. But it measures just 27 inches across, is limited to 60Hz refresh, and doesn't support HDR.

That's partly explained by the 27UD88's signature feature: a UHD or 4K pixel grid. For now, the combination of 4K with high refresh, HDR, and a really large panel isn't available. In fact, the combo of just 4K and high refresh is still a little around the corner. In the meantime, what has LG rustled up to justify a fairly stiff sticker price for such a modestly proportioned panel? After all, 27-inch 4K monitors can be had for under $300.

For starters, the 27UD88 packs a quality IPS panel, while cheap 4K monitors make do with TN tech, and thus inferior colors, contrast, and viewing angles. The 27UD88 also offers a little something to please graphics pros. There's support for 99 percent of the sRGB color space and 10-bit color depth, though the latter is thanks to dithering, rather than native support. The panel itself is eight bits per channel.

Another nifty feature is the upstream USB Type-C port with DisplayPort alternate mode capability. The idea here is to hook up a laptop and do everything over a single cable. That includes drive the display, charge the laptop, and enable the monitor's USB hub for connecting peripherals. If using a laptop as your main rig and hooking it up to external displays is your thing, and you have a USB C-enabled portable, this LG promises to make docking super-simple.

You also get support for AMD's FreeSync tech for smoother gaming and no screen tearing. Just remember that requires an AMD graphics board. Tying it all together is LG's best effort at a premium look: a brushed metal effect stand (actually plastic), a moderately trendy screen enclosure in white plastic, and fairly thin bezels. But what about the actual visuals?

While the 27-inch proportions may be modest, the upside in combination with the 4K resolution is a nice, tight pixel grid. That means lots of detail, and nice sharp fonts. More generally, the panel has a relatively subdued character. It's more natural than particularly punchy. Moreover, the standard factory calibration is nicely judged, with ample detail in black and white scales, and perfectly smooth gradients.

The 27UD88 also gets a brownie point for delivering decent contrast for this class of panel. True, a VA panel typically offers deeper blacks, but the 27UD88 doesn't suffer from the excess of light bleed that blights its sibling, the 38-inch LG 38UC99.

As for the USB Type-C with alternate DisplayPort mode, that failed to function with our test system, an Apple MacBook with its single USB C port. Whether that reflects a problem with the monitor or MacBook was impossible to determine. Our advice would be a little Googling to search for any issues specific to your laptop, rather than assuming all will be well.

The overall upshot is a pleasing, fairly versatile monitor. It doesn't excel in any area. It's not a proper professional screen, nor an obvious choice for gaming. But it doesn't do anything badly, and it does a lot of things well—at a price. –**JEREMY LAIRD**

VERDICT 8

LG 27UD88

⊞ **BEST PICTURE** Lovely IPS panel; tight 4K pixel pitch; USB C connectivity.

⊟ **NOT NOMINATED** Lacks HDR and extended gamut capabilities; expensive for a 27-inch monitor.

$700, www.lg.com/us/monitors

SPECIFICATIONS

Panel Size	27-inch
Native Resolution	3840x2160
Pixel Density	163.36
Panel Type	IPS
Maximum Refresh	60Hz
Response	5ms
Contrast	5M:1 (dynamic)
Display Inputs	DisplayPort 1.2, 2x HDMI, USB C
Connectivity	USB
VESA Mount	100 x 100mm
Warranty	One year

LG's latest combines 4K
with IPS panel quality.

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Cooler Master MasterBox Lite 5 RGB

Meet the new Budget Blueprint

AS A REVIEWER, it's far too easy to get caught up in the razzmatazz of full-sized premium cases and bespoke custom towers. Those rectangular boxes that pack every innovative feature known to man into their voluptuously carved forms appear before us like sirens, singing over the sea. Their enticing figures draw us closer, before the reality sets in as to who exactly is serving who here. Sure, they have their purpose, and the market is certainly there for those who can afford such luxury in their computing lives. But those triple-digit transactions are often an unnecessary indulgence. Such halo products are designed with no more purpose in mind than to instill desire into the consumer, to reinforce the premium feel of a brand, and to make its more affordable options—the true buttresses of a manufacturer—more attractive by proxy.

It's the latter part of that calculation that's the most important. Sure, the flagships may have better margins and the most advanced feature sets, but it's the sub-$100 boxes—capable of distilling those heavenly attributes and condensing them down into a package that's both appealing and affordable—that ultimately win the war.

The MasterBox Lite 5 RGB is one of those offerings: the culmination of a desire to produce an affordable, market-dominating chassis, with all of Cooler Master's latest and greatest design touches trimmed to suit a more down-to-earth audience. This is budget done well. For the experienced, a quick glance over the chassis soon reveals which corners have been cut to make form fit function, yet Cooler Master has done this without impacting the end user in any major manner. The transparent front panel is made of a more affordable plastic polymer, not glass. The dust filters, although small, are intuitively placed to ensure maximum coverage of any and all air intake. The hard drive cage, bottom-mounted below the PSU cover, is non-removable and pop-riveted into position. There's support for four 2.5-inch SSD mounts, with only one bracket included. And a tempered glass side panel is securely fixed in place by a bottom-mounted hinge and just two thumb screws running across the top. The MasterBox Lite is a cunning trickster, a perceptive balance between feature and price. And that's nothing if not a compliment.

FANTASTIC FEATURES

So, the features that impressed us? That tempered glass, of course, plus the PSU cover, the support for up to a 360mm AIO in the front, the three included RGB front fans, the ability to rear-mount the 2.5-inch SSD, if you so desire, and the included white or red accents, which you can swap out on the front panel—they all make this case more than desirable. Couple all that with the stellar $70 price tag, and we're looking at a new budget favorite.

There is one flaw in this master plan, however, and it stems from the material used in the chassis as a whole. Now, we get it: This is a budget box for budget builds, and there has to be some drawback. Unfortunately, the plain black steel used across the exterior and interior of the chassis feels thin, and a little lackluster under the thumb. And as we've seen the same material used in cases for the last 8 years or so, we just wish there was a touch more effort used on the finish, or something different entirely. But, as that's our only sticking point, we'll let it slide.

Cooler Master's MasterBox Lite 5 RGB is a phenomenally priced budget box for any builder looking to construct a modern machine in a case that plays like a flagship. Its feature set is inclusive, its design aesthetically stunning, and its price the perfect balance. What more can be said? **–ZAK STOREY**

VERDICT
9

Cooler Master MasterBox Lite 5 RGB

➕ **LOKI** Incredible design; aesthetically awesome; price point just right; tempered glass; included fans and accessories.

➖ **RUMPELSTILTSKIN** Black steel is bland.

$70, www.coolermaster.com

SPECIFICATIONS

Form Factor	Mid tower
Motherboard Support	ATX, microATX, ITX
Colors Available	Black/red, black/white, black
Window Available	Yes
3.5-Inch Support	2 (2 included)
2.5-Inch Support	4 (1 included)
Radiator Support	360mm front, 120mm rear
Fan Support	3x 120mm/2x 140mm front, 1x 120mm rear
Dimensions	18.42 x 7.87 x 17.89 inches
Graphics Card Clearance	16.14 inches
CPU Tower Clearance	6.3 inches

Roccat Horde AIMO

A cataclysmic collision of keyboard worlds. OK, maybe not cataclysmic…

MEMBRANICAL. MECHANIBRANE. Whichever stupid term you prefer to use, this is—if Roccat's marketing supremos are to be believed—a crossover between the membrane and mechanical worlds, the combination literally everyone in the entire world has been waiting for since the dinosaurs invented the keyboard. At last—society's final remaining problem has been solved. We can die happy. But let's get one thing clear right now: This ain't what we'd call mechanical, despite the neat notched stalks. This is a membrane keyboard. It doesn't have keyswitches—you're mashing down on rubber domes. And however exquisite those rubber domes may be, however high their actuation point is, however tactile the key mechanism may be, this simply isn't as satisfying as a switched board.

Let's un-gnash our teeth for a second, though, because there really is a lot to like about the Horde AIMO. Those keys, squelchy and rubbery though they may be, have been well designed. They're mid-profile (except for the easily distinguished low-profile row of macro keys), yet they've been pulled apart in the layout, giving them the spacing of standard keycaps, rather than the closed-up layouts many lazy membrane keyboards sport. The mechanical bit (as much as we'd like to dismiss it) means that, before your fingers reach the murky bottom, there's a real bite to each keypress. You can feel the activation point coming, and it's high enough that it's possible to go super-light and still type with accuracy.

The fact that every key, including the space bar, has been given the same keyswitch treatment makes the Horde feel consistent and tight, and it is damn quiet. If you're in a sound-sensitive situation—on stream, typing late at night, or in an office where the death stares burn the back of your head the second you start typing—rolling along on this is a more than viable alternative to clattering a proper mechanical number. It's not completely silent, but it's also significantly quieter than a typical full-travel membrane, because the keys don't tap as they bottom-out. The stalk lands on the rubber and it stays there.

Another benefit of the membrane is its ability to spread out the RGB lighting, which emerges in the center of each key dome for the kind of wide coverage you don't typically find elsewhere. We're not going to say that Roccat has hit a home run here, though. It's more of a cleverly whacked bunt that just scrapes first base: Yes, the light shines through, but it's a six-zone setup rather than individual keys, and the way it's piped to the top of the slightly pliable caps, through a clear plastic shaft, gives patchy coverage that doesn't show an awful lot of skill. We weren't able to pull off any long-term wear tests, but the clear caps mean this thing's going to look awful if the mat coating starts to rub away.

SOMETHING TO SHOUT ABOUT

Away from the mechanidome keys, a host of technological tricks earns Roccat a bunch of points. The jog wheel, top-right, is multi-function, and completely compatible with Windows' Dial system. It feels great, and it adds an awesome note of versatility. The media keys are individually lit, toggling to indicate which mode the dial's working on, which is a strangely rare feature. There's anti-ghosting applied to every key in the gaming cluster (though not to the whole board), and the Caps Lock key doubles, if you choose, as an additional macro shift button. At last—a use for Caps Lock other than accidental shouting.

This is the best membrane keyboard we've used, without doubt. It's quite cheap, it's well designed, and the precision of its keys is unarguable. We almost loved it. Then we jumped on to a different machine with a proper mechanical keyboard, and realized how much we'd been taking the joy of clacky switches for granted. Membranical is no substitute for the real thing—it's a parallel universe. If you live in the switched dimension, you won't want to cross over. But if you love domes, this is where you need to be. **–ALEX COX**

VERDICT 7

Roccat Horde AIMO

+ MEMBRANICAL Excellent key separation; quiet action; neat jog wheel.

− HERETICAL Divisive feel to the keys; patchy lighting.

$90, www.roccat.org

SPECIFICATIONS

Switch Type	Hybrid
Form Factor	Full size
Media Keys	5 plus multi-mode jog wheel
Macro Keys	5 dedicated
LEDs	Six-zone RGB
N-Key Rollover	Gaming zone anti-ghosting
Pass-Through	No
Dimensions	9 x 2.3 x 20.8 inches
Warranty	Two years

SteelSeries Rival 600

A Rival with no real rival

BALANCE, AS WE ALL KNOW, is vitally important. Without it, we wouldn't have Segway polo, giant Jenga, or standing up. Does the world of mousing really need a big emphasis on balance, though? Does it need 256 possible levels of side-to-side balance adjustment? Science has perhaps not advanced far enough to tell, but that's what SteelSeries is offering with the Rival 600: a series of eight 4g (about 0.15oz) weights, with eight possible positions to place them (or not place them), four on each lateral edge of the mouse. Pull them all out, and the mouse is light and skippy; stuff them all below the detachable side panels, and it's, predictably, just over an ounce heavier, with a weightier glide.

Depending on your particular right-hand stance (the left-mounted thumb buttons mean this mouse isn't ambidextrous), shifting the weight forward, back, or to either edge can make lifting more efficient and help to reduce bad habits—or at least, that's the theory. In practice, this didn't feel to us much different from the usual base-weighted mice, but your own mileage may vary.

We preferred the Rival 600 fully loaded, because it's not only made for balance; it's meant to be ultra-accurate, too. Tracking error when even slightly lifted is basically zero, thanks to the combination of the same TrueMove 3 sensor we've seen in SteelSeries's Sensei mouse and a secondary lift sensor, which can be set to trigger at a custom height. It's remarkable and a little unnerving, but there's no cursor drift whatsoever. Capable of resolutions up to an unuseably sensitive 12,000 cpi, the TrueMove 3 was already floating around the top of our sensor leaderboard, and it's even better here. If you end up pointing at something you didn't want to point at, that's entirely on you.

Palm grip aficionados may not get on well with the placement of the front-most thumb button. Held comfortably, it's placed just too far forward to reach without shifting the hand, which isn't ideal in a firefight. To be fair, it's more than reachable in claw grip, at which point the rear-most button demands a painful twist of the thumb to access. You can't win. But, at least, there are two accessible side buttons, no matter what your preferred hold. Each of the main buttons is molded independently of the Rival's main body, and afforded a microswitch of just about perfect weight, resisting resting-hand misclicks without any trouble, but remaining light enough to stop your fingers tiring. The wheel, coated with tire-track silicon and nicely notched, takes a fair amount of force to press down; behind it, the two-level resolution toggle is raised just enough that it can be clicked with the second knuckle of the middle finger.

LIGHTS FANTASTIC

While much of the design work has clearly been focused on control, as it should be, SteelSeries has not forgotten the aesthetic side of things. There's a good swathe of RGB lighting running from the edges of the mouse wheel down side panel-hugging strips to an illuminated logo on the base, all compatible with SteelSeries's excellent Prism lighting system. This means you can sync up your compatible gear, and even get visual notifications from the likes of Discord via your mouse, because you need that. Everything's beautifully coated in that grease-magnet soft plastic finish that tends to wear away and get sticky after a few years' solid use (so bear that in mind), and there's an extra dash of silicon on the base of each side grip, adding to the luxury feel and the sureness of the grip. The cable's not braided, but it's replaceable, so we won't dock it any points.

In fact, it's a real struggle to mark down the Rival 600 at all. It's not the cheapest mouse, and there are minuscule niggles that we could pick holes in, but it's an incredible performer where it counts. SteelSeries's design resurgence continues apace—we're just waiting for the Danish hardware wizards to lose their balance. Too cheesy? **–ALEX COX**

VERDICT
9

SteelSeries Rival 600

+ MOUSING Great feel; completely custom balancing; superb sensor combo.

– GROUSING Slightly difficult button placement; quite expensive.

$80, www.steelseries.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	12,000 cpi
Sensor Model	TrueMove 3
Polling Rate	1,000Hz maximum
Programmable Buttons	7
LEDs	Eight-zone RGB
Cable Length	6.5 feet
Weight	3.38–4.5oz

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Roccat Khan AIMO

Is RGB lighting and high-res audio enough to make this king Khan?

CAN YOU HEAR the difference? That's the million dollar question when it comes to this new model in Roccat's RGB-lit range. Boasting 7.1 high-resolution audio support, it can articulate surround sound and sparkling lossless audio at the same time. And, inevitably, it does all that while emitting colored lighting of your choice after loading up Roccat's Swarm software and programing in a set of hues that speak to you. Figuratively, of course; the AIMO lighting system is intelligent enough to synchronize with other compatible peripherals—Roccat's AIMO keyboard and mouse—but it stops short of actually giving those colors their own voices.

In many ways, high-res audio is a natural bedfellow with PC gaming's other obsessions: frame rate, refresh rate, and image resolution. It's an inexorably bound aspect of the hobby, to strive for the absolute best, whether it has any tangible benefit on your experience or not. In that sense alone, the Khan AIMO's audio chops are a selling point.

But let's be real about this: Can you hear the difference? In order to really exploit the benefits of this headset, or any other that supports high-res audio, you need a high-res audio source. Tidal and similar music streaming services offer lossless playback, at a price, so if you're already sufficiently into the idea of hearing Lindsey Buckingham drop his pick and Stevie Nicks clear her throat somewhere in the mix of Fleetwood Mac's *Rumours,* well, these are the cans to listen to it on.

What about games, though? Bethesda's recent *Wolfenstein II: The New Colossus* boasted high-res audio, itself a slightly wooly term that refers to anything above CD-quality 44.1KHz sample rate, and usually double that. But what else? Anyone? Bueller? The chances are the vast majority of games you play with this gaming headset won't make full use of its capabilities. That would be a problem, ordinarily. But it isn't. Not in this case, because the difference between CD quality and high-res is actually quite subtle, to our ears, and Roccat has priced the Khan AIMO low enough that it really doesn't feel as though you're paying a premium for the privilege of high-res sound. We've probably got Kingston's HyperX Cloud series to thank for keeping the sub-$150 headset market so competitive, and it's here that the Khan AIMO fits in among its competitors—the majority of which don't offer this same smorgasbord of features.

NYE ON SUPER SOUND

There's another reason why it shouldn't matter to you that most of what you hear through these cans isn't high-res audio. As a by-product of its construction to meet these specs, the Khan AIMO cans sound great whatever you run through them. Its frequency response range, 10Hz right up to 40KHz, runs well above the standard 20Hz-20KHz most headsets strive for, because it needs all that extra headroom to properly articulate the high-res audio sources when they do come along. So, in the best possible sense, it's overqualified for most tasks you put it through. Like having Bill Nye packing your groceries at the convenience store. Tuned to a pleasingly flat EQ balance, and able to pick out the finer details of even standard quality audio, these are seriously impressive headphones for the money.

But it's evident where compromises have been made to hit this price point. You're never going to pick these up and mistake them for a pair of Bose QC35s: In the absence of costly Alcantara suede and memory foam dressed in soft faux-leather, there's a so-so pair of earpads that become quite hot before too long, and a headband that could use more cushioning or less weight. While we're on the negatives, the volume control is too small and stiff for our liking, too. Points are won for the auto-mic mute when you push its bendy swingarm up, but there's no getting round the Khan AIMO's budget finish. If you can live with that (and the vast majority will be able to), your reward is shockingly good sound for a meager financial outlay. **–PHIL IWANIUK**

VERDICT 9

Roccat Khan AIMO

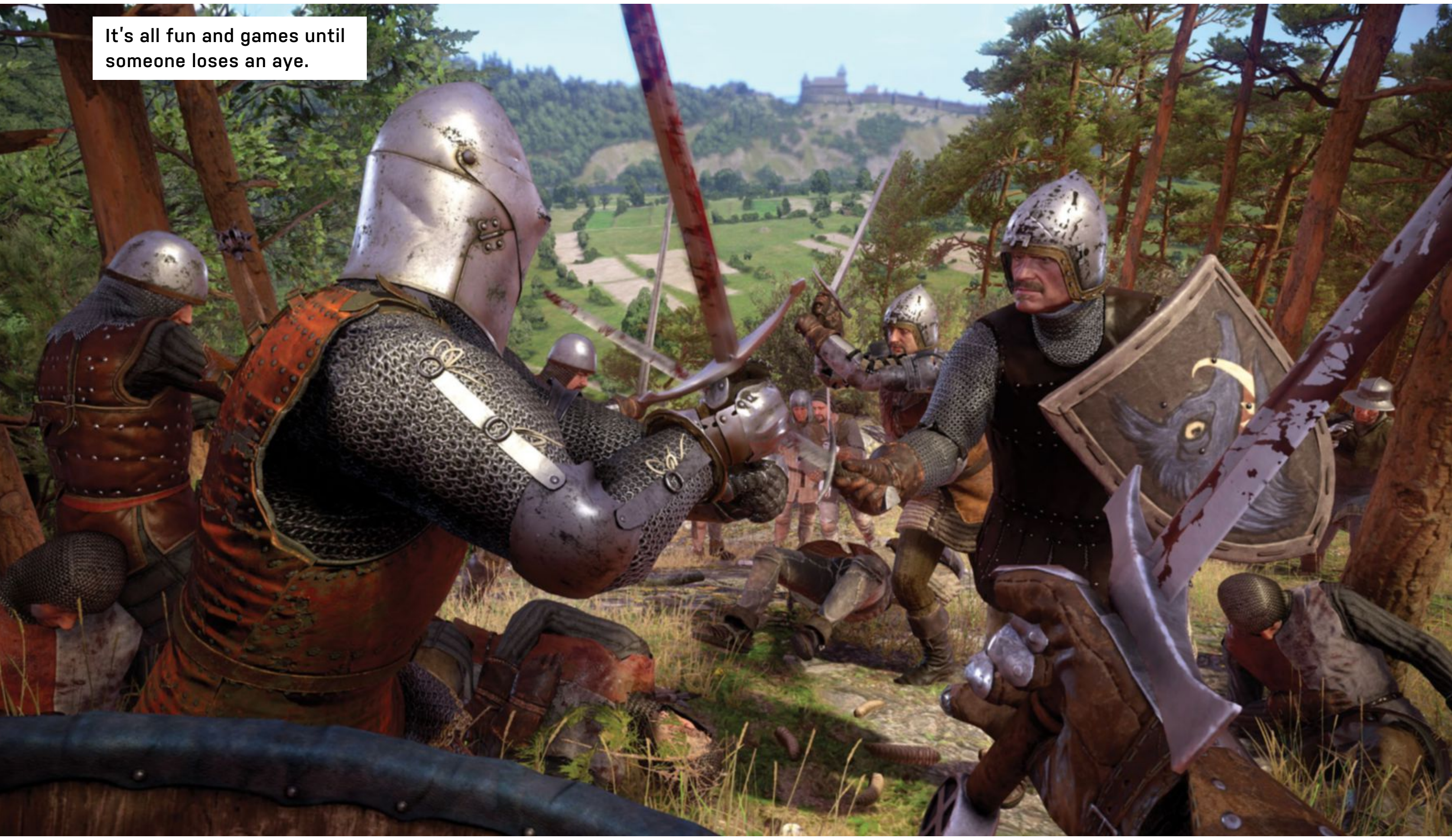
+ OUR BOY GENGHIS Amazing sound; affordable.

– NO KHAN DO Budget construction; awkward volume control.

$120, www.roccat.org

SPECIFICATIONS

Driver Type	50mm
Impedance	32 ohms
Frequency Response	10Hz-40KHz
Design Style	Closed back
Microphone Type	Electret condenser
Connectivity	USB
Weight	9.7oz
Cord Length	7.5 feet



It's all fun and games until someone loses an aye.

Kingdom Come: Deliverance

Young knight lights up the dark ages

MEDIEVAL EUROPE was a dangerous place, we're told. Death could arrive at the point of a sword from any direction, and squabbles between rulers could have devastating consequences for the poor as their effects trickled down the social pyramid.

Into this world is flung Henry, the son of a blacksmith, who spends his days brawling with pals, and delivering nails for his father, a man who knows more about warfare than he lets on. An invading army crashes the party, destroying his village, killing Henry's parents, and forcing him to flee to the next town. From here, he finds himself the plaything of the local lords and of fate, as he tries to recover a valuable sword, and gain revenge on the man who killed his family.

KCD's systems, from the rigid social hierarchy to the way abilities play off one another—such as the need to learn to read before you can do alchemy—seem harsh as you lurch from bed (which saves your game) to breakfast table to make nagging icons go away. This isn't a survival game, surely.

In its quest for realism, *KCD* touches on survival tropes, but they're not the heart of the game. Henry is. He's a likable lad, and will stir your emotions as he grieves for his parents. But he's also a blank slate, ready for you to mold. There are no standard RPG classes, only a list of skills you improve by using them, and perks to unlock. There's also a startling number of equipment slots, enabling you to layer up armor.

Unfortunately, the game isn't without issues. We repeated one sequence many times, constantly being killed by soldiers before eventually escaping, only to have the game vanish, and return us to the desktop, taking our unsaved progress with it. Later, we were unable to climb higher than halfway up some stairs. Our horse's legs sank into the ground. Reloading clears the bug, but that brings up another issue....

The save system. In the base game, you save when you sleep or at developer-chosen checkpoints while on a quest. There's also an expensive alcoholic drink that lets you save, at the risk of getting drunk. This makes progress risky, and prevents save-scumming, so you're always grateful when the sun goes down, and you head off to bed. Within days of the game's release a mod was available to "fix" the problem, and while it's nice not to have to trudge all the way from the last bed you slept in after getting slaughtered at a bandit camp out in the wilds, it removes the sense of Henry's adventure being divided into discrete days.

KCD is an ambitious project, filled with love and detail. Its forests are lush, its villains evil, and watching its amiable hero climb the social ladder on his quest for revenge gives a sense of accomplishment. It's a shame about the technical issues, but that's what patches are for. **–IAN EVENDEN**

VERDICT 7

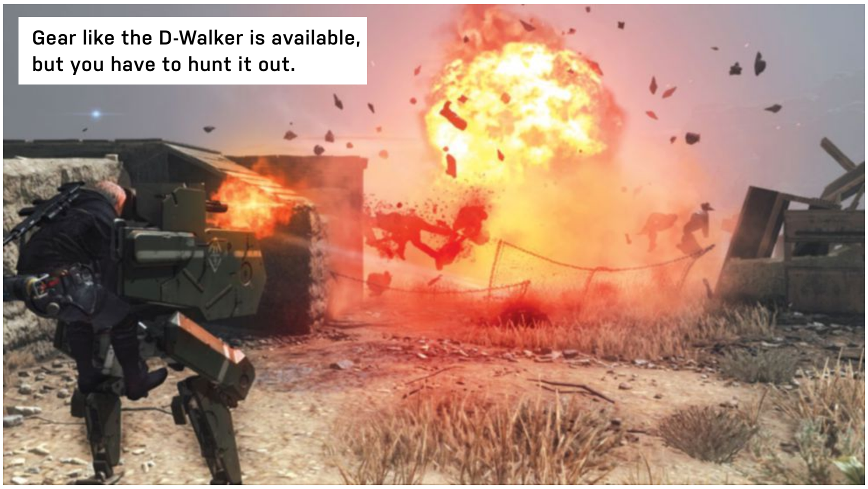
Kingdom Come: Deliverance

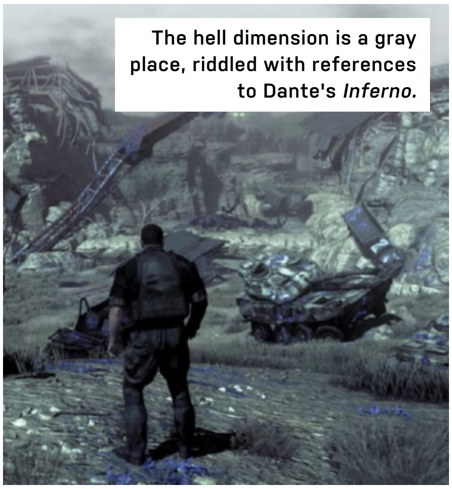
⊞ **DELIVERANCE** Looks and sounds great; deep plot and systems; never boring.

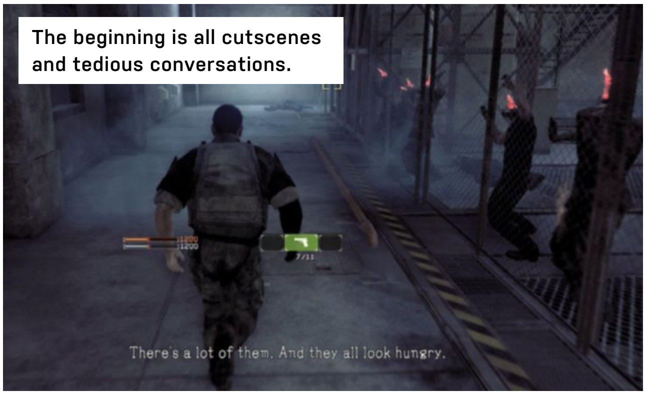
⊟ **INDIFFERENCE** Buggy; frustrating save system; early combat is very hard.

RECOMMENDED SPECS i7-3770/AMD FX-8350; 16GB; GeForce GTX 1060/Radeon RX 580.

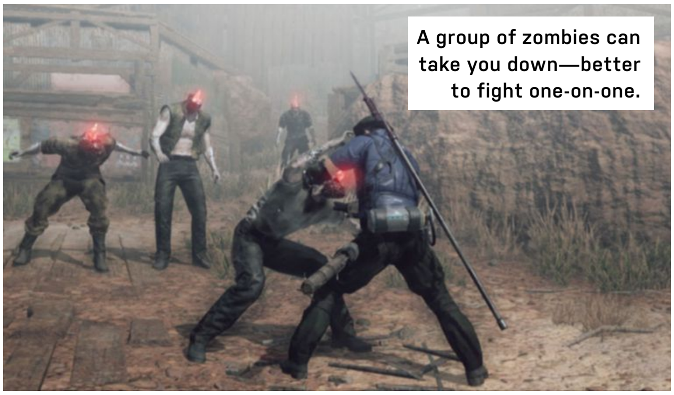
$60, www.kingdomcomerpg.com, ESRB: M


Gear like the D-Walker is available, but you have to hunt it out.


The hell dimension is a gray place, riddled with references to Dante's *Inferno.*



The beginning is all cutscenes and tedious conversations.


A group of zombies can take you down—better to fight one-on-one.

Metal Gear Survive

Stealth franchise takes odd turn into zombie survival

A METAL GEAR GAME without Hideo Kojima at the helm, and a lurch away from stealth toward horror and survival mechanics, this curio turns out to have some shining moments, and some absolute bungles, too.

Set before *The Phantom Pain, Survive* sees Mother Base soldiers sucked through a wormhole into an open-world "hell" dimension populated by a few animals, but mainly dust and zombies. There are smashed vehicle remains, piles of rubble, an AI that looks like a trashcan, the outposts of fellow survivors, and other debris from which to ferret out useful items. But to get to them, you need to brave the dust cloud.

Head in unprotected, and it saps your health, so crafting an air tank should be high up on your priority list. And finding something in the gloom is only half the battle—you need to get back to your base without getting lost and expiring from thirst, running out of air and dying from fog inhalation, or being mauled to death by the Wanderers, human bodies with their heads replaced by a red crystal. You gather Materials to build up your base and craft new gear, which lets you go in search of more Materials, and so on.

We're used to the plots of *Metal Gear* games being a bit mad, but *Survive* takes it to extremes. It's only related to the main series because Konami says it is. It means we have long cutscenes and tedious Codec conversations, but also a recognizable aesthetic powered by a robust engine. It adds to the sense that this is a game made cheaply, a spin-off designed to turn a profit.

On which note: microtransactions. You gain Materials and Kuban Energy (for crafting) by playing the game, while SV coins cost real money (although you get 30 for logging in each day—the game requires a permanent online connection). A slot for a second save file will set you back 1,000 SV coins. But can you buy 1,000 coins? No—they come in packs of 1,150 for $10, leaving you with a useless 150 coins over. Of course, you can get 10 lots of 100 for $9.90, but this seems poor value. An extra weapon slot is 500 coins, but the closest you can buy is 550. It's a system designed to leave you with spare coins, tempting you to buy more to get some use out of them, and its place in a game that costs $40 is questionable.

When actually playing the game, rather than spending money, it feels slow, and is unendingly gray and brown, the red glow of the Wanderers' crystal heads warns of their approach, while other lights in the murk allow you to navigate. You can play single-player with three bots making up the rest of your team, or in co-op, and when it's at its best—holding off waves of Wanderers as a team gathered around a resource—it's a wild and eccentric ride. Unfortunately, there's a lot that drags it down. –IAN EVENDEN

VERDICT
6

Metal Gear Survive

⊞ **SOLID** Dependable Fox Engine looks; decent co-op; flashes of the old magic.

⊟ **TORRID** Microtransactions leave a sour taste; feels laborious to play.

RECOMMENDED SPECS 3.6GHz i7-4790 or better; 8GB; GTX 960 or better.

$40, www.konami.com/mg/survive, ESRB: M

LAB NOTES

JARRED WALTON, SENIOR EDITOR

Prepare for NUC-lear War

Intel's unholy union of Core CPU with AMD graphics is here

IT'S THAT TIME OF YEAR AGAIN, when you can't swing a VR headset without smacking a stack of new processors. AMD's second-generation Ryzen and Intel's second batch of Coffee Lake processors are both preparing for take-off, along with mobile Coffee Lake CPUs for laptops that promise a huge boost in performance for mobile systems. But the processor I'm most excited to poke a stick at is Intel's Kaby Lake-G, with on-package RX Vega M graphics.

I can only imagine how difficult it must have been to create Kaby Lake-G. Intel CPU with AMD graphics sounds cool, sure, but the resistance between the two companies must have been tremendous. It's almost a slap in the face to Intel's whole graphics team—your stuff isn't good enough! And then there's the technical challenge of getting HBM2 and Vega M into the package, and having those communicate with the Core CPU. Intel calls its solution EMIB, Embedded Multi-die Interconnect Bridge, and it does away with the need for HBM's costly and large silicon interposer.

There are some pretty sweet-looking laptops coming out with the new chip, including the Dell XPS 15 2-in-1 and HP Spectre X360. Our first full testing of the Core i7-8809G will come in the form of the new NUC8i7HVK, which I just received, and will start checking out for next month's issue. If you love compact devices like the NUC, this latest version is shaping up to be very impressive.

The new NUC supports six 4K displays and is the smallest VR-ready device around.

Intel also put together a prototype VR vest, with the NUC on the back, Microsoft's Mixed Reality headset with motion controllers, and a massive 300Wh battery. Yeah, it was heavy, but given a wide space to walk around, it was a truly liberating feeling for VR. Battery life for the prototype was only about two hours, and there's plenty of room for improvement, but this is the ultimate future of VR/MR/AR.

ALAN DEXTER

Executive Editor

There's a correlation between cost and expectation. If something costs a fortune, I want it to work perfectly. For instance, if I've dropped $5K on a screen, I expect it to work in the simplest way possible; not, say, needing a pair of HDMI cables. It works the other way as well, though, and I'm quite prepared to jump through a few hoops in order to get a $35 Raspberry Pi working just the way I want it.

This ethos extends to the budget PC I built this issue. It costs a reasonable amount, but not a fortune, so the fact that the MSI motherboard only supports 4K at 30Hz when using the HDMI connector was a frustration, if not a deal-breaker. This is obviously a limitation of the bandwidth of the HDMI 1.2 interface, rather than anything more sinister. You could also argue that if you're intending to drive a 4K display, you should use something beefier than a $100 chip in a $90 mobo.

This is part of the problem I have with the price hikes we've seen on RAM and graphics cards. With the skewed value proposition, there's an expectation that the gear should perform and act as such. This, unfortunately, can't be the case, because these components weren't originally spec'd at the price points they now find themselves commanding. Well that, and the fact that I don't like paying over the odds for gear that doesn't warrant the outlay.

Editors' Picks: Digital Discoveries

Bo Moore, technology editor, and Zak Storey, deputy editor, share their prized peripheral passions

RAZER MAMBA AND FIREFLY HYPERFLUX

I've been using Razer's Mamba Tournament Edition as my daily mouse for a while now, so when Razer sent me the new HyperFlux wireless edition, I had to check it out. A few weeks later, I'm a wireless convert.

The Mamba HyperFlux is nearly identical to its wired predecessor in design, the only notable difference being the honeycombed grip has changed into more of a ribbed pattern. The biggest difference, obviously, is the move from wired to wireless. But unlike most wireless mice, the Mamba HyperFlux never needs to have its battery changed. In fact, it doesn't have a battery at all.

Power is provided via the Firefly HyperFlux mouse mat, which wirelessly sends power to the mouse. Without a battery, the Mamba is one of the lightest wireless mice around (only 96g), but it powers down if you remove it from the mouse pad for too long—after about 15–20 seconds.

Even restricted to just the Firefly mouse mat, I'm loving the freedom of the HyperFlux Mamba. I haven't had any issues with connectivity, and the lightweight, cord-free rodent is helping me land my headshots even more consistently. Now, if only my cats would stop knocking it off my desk!

$250, www.razerzone.com

WACOM INTUOS PRO

This might surprise you, but I'm quite skilled at Photoshop. *World of Warcraft* brought me into the realm of user interface design in 2008, and since then, I've been working on custom interfaces, panels, and textures on an almost weekly basis. I wouldn't be where I am today without it—crafting everything from websites and résumés to candle labels and gig posters, it's secured jobs, helped hone my mind, and even saved my degree once or twice.

However, when it comes to drawing, I'm about as talented as a trash panda. That's why I wanted to get Wacom's Intuos Pro in for review. Until now, I've only ever used a mouse for my design work, and it doesn't have the subtlety I need, especially for tracing outlines and creating unique art, so I figured I'd try something more intuitive.

Wacom's Intuos Pro is the company's most prestigious product. Coming in two sizes, and packing all sorts of neat features, from pressure sensitivity to tilt support and minimal lag, it suits my needs perfectly. Driver setup can be a little tricky, especially in a commercial environment, and there is a definite learning curve (thanks, YouTube), but it does the job, and does it well, which you'd expect given the price.

$350, www.wacom.com

GEEK TESTED & APPROVED

Corsair ST100 Stand

WHY ON EARTH do we have this thing in? I'd be a liar if I said I didn't already own a headphone stand. I have one at home, a cheap $20 aluminum affair, an impulse buy from Amazon to complement the custom desk I built in 2016. I love my audio, and as I've got a sweet pair of Beyerdynamic DT 1770 Pros to cushion sound waves around my rather small earlobes, I needed something to store them on. Thus, the stand. There's a whole plethora of them out there, too: plastic ones, wooden ones, ones you attach to the underside of your desk, even ones baked into screens and cases. If you can think of it, some odd-named third-party company has probably made it. It's a big market, and I'm surprised the mainstream peripheral manufacturers haven't jumped into it sooner.

So, let's talk about the ST100. What's so special that it deserves the $60 price tag? Well, it's a Corsair product, so there's RGB. But possibly slightly more impressive is the inclusion of a tiny USB DAC, embedded into the undercarriage. Enabling a modicum of digital audio, it sounds OK. It also has support for digitally synthesized 7.1 surround sound, as well, but as we've come to expect from those kind of systems, that's still pretty crappy.

Ultimately, it's a fairly expensive, light-up, aluminum USB hub and audio pass-through, which you can also just happen to put your headphones on. Is it worth it? I'm not convinced.... **–ZS**

$60, www.corsair.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Mouse Marvels
> Driver Clashes
> Budget Builds

Upright Mice

The "vertical mouse" is an ergonomic innovation that only recently came to my attention. After feeling wrist pain, I'm experimenting with several, and discovering how different they are in terms of angle and grip. The fundamental idea that a "handshake position" is more natural than the standard mousing hand position does make intuitive sense. And you can buy a decent vertical mouse for as little as $10. This all may be worthy of some discussion in your mag. **–David Rolfe**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: There are several vertical mouse advocates in our office, and I've had the chance to try quite a few different designs over the years. The problem is that despite my best intentions, I've never found them particularly comfortable. Not that I'll hold that against you. The beauty of the PC, and computing in general, is that if you find something that works for you, you can go for it. And if there's anybody else who has an opinion on a slightly non-mainstream peripheral, please drop us a line. There you go, consider the discussion started.

Windows 7 EOL

Windows 7 security updates end in Jan 2020, so business as usual is not a good long-term plan for Win 7 systems. The Meltdown and Spectre bugs are out there, and possibly more likely to affect older hardware or OSes.

My Intel 2500K system is humming along just fine on Win 7, although occasionally straining against available resources. I have so many applications that I'm not willing to upgrade—this will be a new build. If I were to do it now, it would likely be an 8600K with double my RAM, replacing my boot SSD with double the NVMe, and replacing the HDD with enough SATA SSDs to store double the data. Single-threaded performance is most important to me. It's sad that the 8600K clock speed is less than 10 percent higher than my 2500K from 2011, although the two extra cores will get used.

Should I upgrade now, or wait a year, in the hope that new CPUs will contain fixes for Meltdown and Spectre? Or am I more exposed running Windows 7 and the 2500K now? Whenever I do upgrade, I could conceivably run the new system for a decade or more. On the other hand, I'm not comfortable waiting much more than a year, say, beyond April, 2019, because upgrades can be complicated with all that software. **–Pete Matthews**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: While Spectre and Meltdown are serious, they're unlikely to have much impact on desktop machines, especially if you follow a proper security regime. There is a problem here, of course: By January 2020, it will be difficult to follow such a regime when the OS itself is no longer seeing fundamental updates. That does mean you've got some time to make the transition, and if you're generally happy with the performance of your machine, we don't see any reason why you'd want to push it forward. If you are itching for new hardware, there's a lot going for the 8600K, and you'll feel the benefits of an overhauled storage system made up of NVMe drives and standard SSDs. But as for waiting for the next chips, there may be more exploits to surface, then you're back waiting again. There's always something new and exciting over the horizon, but sometimes there's also something even nastier.

Problem Software

Regarding your article on free PC software, you recommend Malwarebytes. I used to use Malwarebytes, and had a paid subscription at one time, but it keeps messing up DriverUpdate. I've contacted Malwarebytes and DriverUpdate, and both say they are working on the issue, but that was over a year ago now, and I just reinstalled Malwarebytes after seeing your article, and once again it is trying to uninstall DriverUpdate.

Sure, you can go through and uncheck the many boxes that Malwarebytes lists identifying pieces of DriverUpdate as Potentially Unwanted Program (PUP), but even then, on further scans more DriverUpdate items show up. It is a huge pain to keep these two programs playing nice with each other. I've stopped using Malwarebytes because of this, as I like keeping my drivers up to date. Is

↘ submit your questions to: comments@maximumpc.com there something wrong with DriverUpdate I should know about? **–Steve Ruegsegger**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: DriverUpdate is a legitimate program, but due to the way it works (and partly because it was bundled with many apps without users realizing they were installing it), it is flagged by many security programs as problematic. As there is a conflict between these two, we recommend keeping the program that has the most benefit to your system, and in our view that's Malwarebytes. You don't really need DriverUpdate, as Windows does a great job of keeping your devices up to date, with the possible exception of graphics drivers, but AMD and Nvidia handle this well enough in their own software.

[NOW ONLINE]

WHAT ARE PAGE AND SWAP FILES, AND HOW BIG SHOULD THEY BE?

While you probably don't need to adjust your PC's page and swap files, it's useful to know what they are when troubleshooting, or if you're trying to free up a little hard drive space.

What is a page file?

A page file acts like a physical extension of RAM, and is used to offload excess or idle data from the memory to the hard disk. It's necessary because if the main system RAM is overloaded, and no page space is available, a program could crash and potentially lose data.

What is a swap file?

The swap file and page file perform the same function. Swap files are also a reserved section of disk space used to offload data from RAM. One of the swap file's primary functions is to provide a page space for Windows apps from the Windows Store. When a Windows app enters idle mode, it's unloaded into the swap file until the user reactivates it. This frees up memory for more important tasks that are running.

Read the full article at https://bit.ly/2I6wqTU

Budget Size

In your end-of-the-magazine builds, you discontinued ATX budget builds in favor of ITX budget builds. Please bring back the ATX ones. If needed, you can redesign the magazine's last two pages to include four sections instead of three (the mid-range and turbo builds will fit on the last page, if you relocate "Upgrade of the Month").

–Steve Schooler

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: You'll be pleased to see that we've got two full ATX budget builds this issue as part of the main feature, giving you plenty of ideas for your own builds. In fact, that's the concept behind these builds: You can build them as is, or you can use them as the basis for your own builds. Sometimes, these will be ATX, sometimes ITX, and now and again we may even try to squeeze a microATX build in there.

Digital Format

I just added a *Maximum PC* digital subscription to my print subscription. The instructions provided in the emailed receipt point to www.myfavouritemagazines.co.uk/digital-magazine-download-instructions/, and are only for iOS and Android.

As a result, I was initially very unhappy. It took me a few minutes to realize the "Android" Google Play Newsstand was available on the web, too, and therefore accessible from my PC. I understand these instructions are provided for all digital magazines sold by Myfavouritemagazines, but given you're a PC magazine, the fact it's viewable on PC should be made clearer to your readers.

–Robert Tortorelli

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: Nice tip, Robert. I'm sure there are plenty of readers who didn't realize you could do this, and it means that you have easy access to your issues on a variety of devices.

Flying Pigs

When I saw this line in *Maximum PC* in the budget build blurb: "in fact, a console may even be a better bet in the short term," I looked out the window to see if pigs were flying. Admittedly, my opinion has always been that a console is usually but not always a better bet than spending money on hardware that one could spend on games. But I run Linux, and a PS4 complements it well. Now, admittedly, if people want to play a PC-only game on a budget, such as *FTL*, *WoW*, or *LoL*, they're stuck with Windows on PC.

As for that overpriced 1050 Ti, where did you find it for just $220? I have the SC version of that card in my Linux box. I picked it up last year for $140 on Amazon, but it's showing as $260-plus on Amazon, and $239 on EVGA's website. Surely miners can't be so desperate for GPUs that they're using GTX 1050s? Or is it that gamers can't get the cards they really want, so are settling for 1050s, thus driving up the price for those who truly want to use one in a budget build? **–Ron Rogers Jr.**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: This was born out of our frustration with the state of the graphics market at the time, but the good news is that things are starting to return to normal—see this month's builds for proof. Either way, we're back recommending that people build PCs and avoid consoles like the good old days (although we really don't have a problem with the current consoles, if that's your thing).

Testing Times

In the Spring 2018 issue, on page 65, you recommend using the Ultimate Boot CD to reset a forgotten user password in Windows 10. I downloaded the software and installed the .ISO on to my USB stick using ISO2Disc. When I boot the PC—a Dell XPS 8750, i7-4770 3.4GHz, 16GB, UEFI BIOS set to Legacy Boot—I am only able to run the Memtest86 utility. How can I gain access to the other useful utilities that are also included with the UBCD package?

–Reddex Washington

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: Try turning the Legacy Boot option off in the BIOS and then trying again. There is a known problem with the option and the Memtest86 utility, which may be overwriting some of the memory contents, which means the other options aren't showing up.

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THE BUILDS

BUDGET

MID-RANGE

INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Evolv ITX	$70
PSU	Corsair VS450 **NEW**	$40
Mobo	ASRock AB350 Gaming-ITX/ac	$85
CPU	AMD Ryzen 5 2400G	$163
GPU	N/A	$0
RAM	8GB (2x 4GB) G.Skill Ripjaws 4 Series 3200	$103
SSD	120GB HP M700 2.5-inch SSD	$50
HDD	Western Digital Blue Series 1TB 7,200rpm	$46
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit	$16

Approximate Price: $573

BOOM, LOOK AT THAT: $22 savings off last month. It's happening people—prices are tumbling, memory prices are sort of coming down slowly, and we're even scraping savings from the most unlikely of places. We've gone for a cheaper PSU this time around, mostly because EVGA's 450BT is now out of stock. That said, Corsair's still a solid brand, and this 80 Plus White PSU will be more than enough for our rig, even with a GTX 1060 thrown in for good measure later in the year (or whatever fancy new mid-range GPU Nvidia might be releasing in the next few months). That aside, not a huge amount has changed for our budget build. The case is the same, the processor, the mobo, hard drives, and our chosen OS—all of it is still as solid as it was last month. Give it another quarter, and we're positive that both GPU and memory prices will have fallen just enough for us to start recommending dedicated graphics cards once more.

INGREDIENTS

PART		PRICE
Case	NZXT S340 Elite	$80
PSU	550W Corsair RM550X	$100
Mobo	MSI Z370 Tomahawk	$150
CPU	Intel Core i5-8400	$179
Cooler	Be Quiet! Dark Rock 3	$75
GPU	Gigabyte GeForce GTX 1060 3GB **NEW**	$280
RAM	16GB (2x 8GB) Team T-Force Vulkan 2400 **NEW**	$168
SSD	250GB Samsung 960 Evo M.2 PCIe SSD **NEW**	$120
HDD	Western Digital Blue Series 1TB 7,200rpm	$46
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,298

ANOTHER $56 HAS FALLEN OFF the price of our mid-range build this month, and that's with a $20 price hike on our SSD choice, too. This is also the first time we've seen GTX 1060 3GB prices fall below the $300 mark, in what seems to be a return to some semblance of sanity when it comes to pricing. That GPU is no slouch either, being a dual-fan design. We've also swapped out to a Team T-Force Vulkan memory kit, which shaves off the grand sum of $1. This is also the last time we'll be seeing the NZXT S340 Elite, because we have three brand new cases lined up for next issue, ready to enter the "Blueprints" hall of fame for the next six months or so. So, apart from retiring the NZXT S340 Elite, is anything else likely to change? Potentially the processor. Although we're not 100 percent sure yet, rumors have been speculating that Intel may indeed be releasing an eight-core variant of its Coffee Lake line-up.

TURBO

A SAVING OF $185 this issue—that's a pretty epic feeling. We haven't seen any major decreases in our GPU of choice this time around, but there have been a few savings elsewhere. The big change this month comes from the storage, but it's something we're still not entirely sold on. In today's age of advanced NAS solutions, private servers, and cloud storage, the argument for masses of on-site capacity seems a little mute. We're keeping 4TB of hard drives in here for the time being (operating in RAID 1), purely for the sake of redundancy, but we consider filling up those 2TB locally a challenge.

That's not to say it isn't possible. But is it worth arguing for in a turbo build in today's climate? Would it be worth dropping them in favor of running some higher capacity solid-state storage instead? After all, if you're looking at a build at this price point, the likelihood is that you've already got an ample backup storage solution in your own home, if not located elsewhere.

We're fairly happy with where this build is at. If the GTX 1080 Ti falls in price a little more, we'll likely throw the extra cash at the 16-core 1950X instead. It's possible that, in the next few months, we may see a Zen+ variant of Threadripper and a new chipset, but we doubt there'll be much buyer's remorse. After all, with all the I/O on the chip itself, if all it lends itself to is an additional 10 percent performance, that's certainly not worth upgrading for.

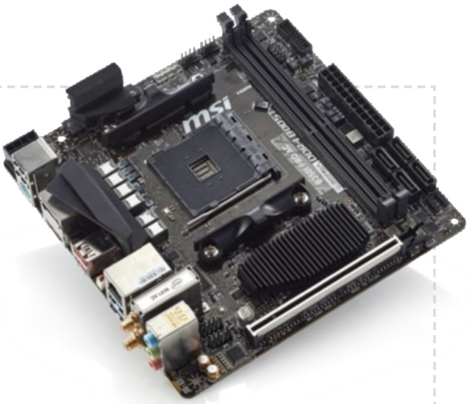
For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART		PRICE
Case	Phanteks Eclipse P400S Tempered Glass Silent Edition	$90
PSU	Corsair RM750X Modular Gold	$110
Mobo	Asus Prime X399-A	$315
CPU	AMD Ryzen Threadripper 1920X	$668
Cooler	Noctua NH-U12S TR4-SP3 120mm	$70
GPU	Zotac GeForce GTX 1080 Ti AMP Extreme **NEW**	$910
RAM	32GB (4x 8GB) G.Skill Ripjaws V DDR4 3000 **NEW**	$362
SSD	512GB Samsung 960 Pro M.2 NVMe	$330
HDD	2x 2TB Seagate BarraCuda **NEW**	$110
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $3,065

UPGRADE OF THE MONTH



MSI B350I PRO A/C

It may not have won our coveted Kick-Ass award, but dang it, this motherboard is a top-notch upgrade. Now, we know, y'all have mixed feelings about form factors, but if ITX is your jam, and you're still stuck on a second or third-gen Intel part, this might be the opportune moment for you to move up to a more modern platform. MSI's B350i Pro is a fantastic combination of affordability, utility, and performance, with a stunning BIOS, and all the connectivity you could want in a small form factor PC. It's hard to argue with just how much this $100 diva brings to the table. Combine it with a Ryzen 7 1800X, 16GB of DDR4 RAM, and a GTX 1080 Ti, and you're looking at a kick-ass 4K gaming rig that'll render like a champ, too.

$100, www.msi.com

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